MAY 15 1922

Printed on Thin Paper for Foreign Circulation.

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXIII.—No. 3448] LONDON: FRIDAY EVENING, JANUARY 27, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The Maintenance of Tidal Berths.

Electrification of English Main Line Railways

Sanitary Engineering in 1921.

1600 B.H.P. Nobel-Diesel Marine Engine.

Institution of Mechanical Engineers.

Electrical Engineering in 1921.

Tug with Grain-Ship Discharging Plant.

Utilisation of Exhaust Steam.

Single and Three-Phase Electric Motors.

Angle Compound Air Compressor.

Recent Sewage Treatment Methods.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—
(1) COPPER FIRE-BOX PLATES.
(2) SPRINGS, HELICAL, &c.
(3) AXLE-BOXES, LOCOMOTIVE, CAST STEEL.

Forms of Tender may be obtained from the Director General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 14th February, 1922, for No. 1, and on Tuesday, the 21st February, 1922, for Nos. 2 and 3.

T. RYAN,
Director-General.
7250

Civil Service Commission.
FORTHCOMING EXAMINATION.
ASSISTANT ENGINEER in the Engineer-in-Chief's Department of the General Post Office (20-25, with extension in certain cases), 2nd March.

The date specified is the latest at which applications can be received. They must be made on forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1. 7253

British Standardised Steel
SAMPLES,
Issued jointly by
THE IRON AND STEEL INSTITUTE
AND THE
NATIONAL PHYSICAL LABORATORY.

These samples are now available, together with certificate of standardization, at the price of 21s. per bottle, containing 50 grammes. They may be obtained post free by sending order with remittance, direct from
THE NATIONAL PHYSICAL LABORATORY
(Metallurgy Dept., Teddington, Middlesex;
or by post or personal application from
The Secretary, NORTH MIDLANDS DISTRICT AUTHORITY, Dept. of Applied Science, The University, Sheffield.

Depots in other centres are being arranged.
The Standards at present available are :—
No. 5 Carbon (C = 0.65 per cent.) Acid O.H. Steel.
No. 6 Carbon (C = 0.10 per cent.) Basic O.H. Steel.
No. 1 Sulphur (S = 0.027 per cent.).
Others are in preparation and will be issued when ready. 7248

Alteration to Hot Water
SUPPLY for Heating and Domestic Purposes at Winchester Poor Law Institution.
Also for NEW MACHINERY in Laundry.
Deposit £3 3s.

F. FAITHFULL,
Clerk to the Guardians.
105, High-street, Winchester,
13th February, 1922. 7224

Borough of Hammersmith.
GENERAL ELECTRICITY STORES.
The Borough Council invites TENDERS for the SUPPLY of the following STORES for alternative periods of 3, 6, or 12 calendar months, commencing on the 1st April, 1922 :—
1. BROOMS AND BRUSHES.
2. ELECTRIC LIGHT SUNDRIES.
3. FILES.
4. FIRE-BRICKS, CLAY AND LIME.
5. INSULATED WIRE.
6. METALS.
7. OILMAN'S GOODS.
8. PACKING AND JOINTING MATERIALS.
9. TOOLS.
10. JOINT BOXES AND CONNECTIONS.
11. METERS.
12. SCREWS.
13. IRONMONGERY.
14. STONEWARE CONDUIT.

Forms of Tender and further particulars can be obtained on application to Mr. G. G. Bell, Borough Electrical Engineer, 85, Fulham Palace-road, W. 6, upon receipt of a stamped addressed brief envelope, and where duplicate copies are required a remittance of 2s. 6d. must be made.

Sealed Tenders, endorsed "Tender for Electricity Stores," must be delivered to me at the Town Hall, Hammersmith, not later than 9 p.m. on Wednesday, 22nd February, 1922. The Council does not bind itself to accept the lowest or any Tender.

LESLIE GORDON,
Town Clerk.
Town Hall, Hammersmith, W. 6,
25th January, 1922. 7238

City and County of the City
OF CHESTER.
QUEEN'S PARK SUSPENSION BRIDGE.
TENDERS are INVITED for the TAKING DOWN and REMOVAL of the existing SUSPENSION BRIDGE and the ERECTION of a NEW WIRE ROPE SUSPENSION BRIDGE in place thereof.

Specification and drawings may be obtained and conditions of contract inspected at the office of Mr. Charles Greenwood, Assoc. M. Inst. C.E., City Engineer and Surveyor, Town Hall, Chester, on and after the 27th inst., on payment of a deposit of £2 2s., which will be refunded on the receipt of a bona fide Tender.

The contractor will be required to conform to the conditions laid down by the Unemployed Grants Committee, a copy of which may be obtained at the above office.

Sealed Tenders, endorsed "Suspension Bridge" and addressed to the undersigned, should be delivered at my office not later than 9 a.m., 28th February, 1922.

The Council does not bind itself to accept the lowest or any Tender.

J. H. DICKSON,
Town Clerk.
Town Hall, Chester,
23rd January, 1922. 7243

The National Foremen's Association of the ENGINEERING AND ALLIED TRADES.
(Registered under the Trade Union Act.)
An Association specifically formed to look after the interests of Foremen in their Supervisory Capacity.
All communications to Head Office,
H. W. REID, 85, Belgrave-road,
General Secretary. Victoria, S.W. 1.

PUBLIC NOTICES

London County Council.
TENDERS are INVITED for the SUPPLY and DELIVERY in London of about 2500 TONS and, alternatively, of about 4500 TONS of STANDARD STEEL GIRDER TRAMWAY TRACK RAILS, with FISH-PLATES thereto.

The specification, drawings, bills of quantities, form of Tender and other particulars may be obtained on application to the Chief Engineer of the Council, at Gloucester House, 19, Charing Cross-road, W.C. 2, upon payment to the Cashier of the Council of the sum of £2. This amount will be returnable only if a bona fide Tender is submitted and not withdrawn. All particulars may be obtained on application at Gloucester House before payment of this fee.

Tenders are to be delivered at the County Hall in a sealed cover, addressed to "The Clerk of the London County Council, Spring-gardens, S.W. 1," marked "Tender for Track Rails and Fastenings." No Tender received after 4 p.m. on Monday, 13th February, 1922, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
7246 Clerk of the London County Council.

London County Council.
TENDERS are INVITED for the REMOVAL and DISPOSAL of SEWER DEPOSIT and other material in connection with the Main Drainage, &c., services for four districts—two north of the Thames and two south of the Thames, east and west respectively, for a contract for twelve months commencing 1st April, 1922.

Persons desiring to Tender may obtain on and after Monday, 30th January, 1922, form of Tender, &c., on application to the Chief Engineer, at 19, Charing Cross-road, W.C. 2, upon payment to the Cashier of the Council of the sum of £1. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract document may be inspected before the payment of the fee.

No Tender received after 4 p.m. on Monday, 13th February, 1922, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
7276 Clerk of the London County Council.

London County Council.
TENDERS are INVITED for GENERAL WORKS and REPAIRS (including jobbing work), exclusive of works of a mechanical character, to Sewers, Engine-houses, Buildings, Bridges, Subways, Tunnels, &c., under the supervision of the Chief Engineer of the Council, on a schedule of prices for a contract for twelve months, commencing 1st April, 1922.

Tenders are asked :—
(a) For the WHOLE of the WORKS on BOTH SIDES of the River Thames.
(b) For the WORKS on the NORTH SIDE of the River Thames only, but including THAMES BRIDGES and TUNNELS.
(c) For the WORKS on the SOUTH SIDE of the River Thames only.

Persons desiring to Tender may obtain on and after Monday, 30th January, 1922, the schedule of prices, form of Tender, &c., on application to the Chief Engineer at 19, Charing Cross-road, W.C. 2, upon payment to the Cashier of the Council of the sum of £2. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract document may be inspected before the payment of the fee.

No Tender received after Twelve Noon on Tuesday, 21st February, 1922, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
7277 Clerk of the London County Council.

PUBLIC NOTICES

East Indian Railway.
The East Indian Railway Company is prepared to receive TENDERS for the SUPPLY and DELIVERY of :—

LANCASHIRE BOILERS,
as per specification to be seen at the Company's offices.

Tenders are to be sent to the undersigned, marked "Tender for Boilers," not later than Eleven o'clock a.m. on Wednesday, the 15th day of February proximo.

The Company reserves to itself the right to divide the order, also to decline any Tender without assigning a reason, and does not bind itself to accept the lowest or any Tender.

For each specification a fee of £1 1s. is charged, which cannot under any circumstances be returned.

By Order,
G. E. LILLIE,
Secretary.
Nicholas-lane, London, E.C. 4,
26th January, 1922. 7286

Metropolitan Water Board.
TENDERS FOR PIPE LAYING, REPAIRS AND ALTERATIONS TO MAINS, &c.

The Metropolitan Water Board invite TENDERS for PIPE LAYING, REPAIRS and ALTERATIONS to MAINS, &c., for periods of three, six, or twelve months from the date of acceptance.

Tenders must be made on official forms, which may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1 (Room 150), on or after Wednesday, 1st February, 1922, by personal application or upon forwarding a stamped addressed brief envelope.

Tenders must be sent, under sealed cover, addressed to the "Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," endorsed "Tender for Pipe Laying, Repairs, &c.," and must be delivered at the offices of the Board not later than 11 a.m., Tuesday, 14th February, 1922.

The Board do not bind themselves to accept the lowest or any Tender.

W. MOON,
Clerk of the Board.
New River Head,
173, Rosebery-avenue, E.C. 1,
25th January, 1922. 7279

Sheerness Urban District Council.
REPAIRS TO PIER.
TENDERS FOR STRUCTURAL STEEL WORK.

The Sheerness Urban District Council invite TENDERS for the SUPPLY of about 10 TONS of STRUCTURAL STEEL WORK.

Copies of the specification, schedule and drawings may be obtained on application to the Surveyor, Council Offices, Trinity-road, Sheerness.

Sealed Tenders, endorsed "Tender for Steel Work," are to be forwarded to my office on or before Wednesday, the 15th of February, 1922.

By Order,
VINCENT H. STALLON,
Clerk of the Council.
Clerk's Office, Sheerness,
23rd of January, 1922. 7236

CEMENT GUN AND PORTABLE AIR COMPRESSOR.

The Swansea Harbour Trustees invite TENDERS for the HIRE for about two years of a CEMENT GUN and PORTABLE AIR COMPRESSOR, together with all necessary hose and fittings complete.

Further particulars may be obtained on application to the Trustees' Engineer at the Harbour Offices.

Tenders, sealed and marked "Tender for Hire of Cement Gun and Compressor," to be delivered to the undersigned on or before Friday, the 17th February, 1922.

The Trustees do not bind themselves to accept the lowest or any Tender.

TALFOURD STRICK,
Clerk to the Trustees.
Harbour Offices, Swansea,
26th January, 1922. 7282

PUBLIC NOTICES

Government of Bombay.
BOMBAY DEVELOPMENT DIRECTORATE.
AMBERNATH INDUSTRIAL AREA.
SEWAGE SCHEME.

The Director of Development is prepared to receive TENDERS up to Twelve Noon on Wednesday, 15th March, 1922, for the CONSTRUCTION and RUNNING for six months of a SEWAGE INSTALLATION capable of dealing with the sewage and sullage water of an area containing 9000 people. The installation must be capable of dealing with about 1,10,000 gallons of liquid per day, and should not include the provision of sewers, which are being arranged for separately.

Tenders should be accompanied by earnest money of Rs. 500 (five hundred only), which will be returned to the unsuccessful tenderers and will be retained in the case of successful tenderer as part of the security deposit.

The Director of Development does not bind himself to accept the lowest or any Tender.

For particulars apply to the SUPERINTENDING ENGINEER, No. 3 Project Division, Directorate Building, Old Custom House-yard, Fort, Bombay.

N.B.—Ambernath is a new satellite town for the development of manufacturing industries and is situated on the G.I.P. Railway, 40 miles north-east of Bombay, India. 7140

Tenders are Invited by the Government of New South Wales for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1600ft. in the clear, centre to centre of main piers, or 2000ft. centre to centre of anchor piers. The total length of bridge included in Tender is 3816ft., centre to centre of abutments. The deck of the bridge is to include four lines of railway, and a roadway 35ft. wide, between main trusses; and cantilevered outside the main trusses on the western side, a footway 15ft. wide, and on the eastern side a motor roadway 18ft. wide. Copies of specification, including plans, general conditions and schedule of quantities may be obtained on application to the undersigned.

To give any information required by tenderers, Mr. J. J. C. Bradfield, Chief Engineer, will be in London during June and July, 1922, address care of the undersigned.

Tenders in accordance with the specification must reach the Under Secretary for Public Works, Sydney, not later than 31st October, 1922.

AGENT-GENERAL
FOR NEW SOUTH WALES,
Australia House, Strand, London, W.C. 2,
December, 1921. 7086

SITUATIONS OPEN

ASSISTANT DESIGNER for Centrifugal and Turbine Pump Work.—This POST has now been FILLED and we wish to thank all applicants.—W. H. ALLEN SONS and CO., Limited, Bedford. 7262 A

WANTED, a Technically Trained CIVIL ENGINEER SUPERINTENDENT who has had experience in breaking up and removing large masses of rock, such as very heavy railway cuttings, iron or copper open pit work or big hydraulic canals. Vacancy is for large English company in Spain. Single man and college graduate preferred and steam shovel experience in hard rock essential. Also WANTED, practical STEAM SHOVEL FOREMAN, to Manage and Instruct Steam Shovel Drivers and Manipulators.—Write, stating full experience, salary expected, age, married or single, if any knowledge Spanish, to "T. A.," c/o Street's, 30, Cornhill, London, E.C. 3. 7273 A

WANTED by Firm of Machinery Exporters, YOUNG MAN of good education and all-round engineering experience, particularly in Machine Tools, required to assist in compilation of Machinery Export Catalogue and, after publication, to travel abroad soliciting orders. Applicants to state age, salary required, training and business experience.—Address, P4763, The Engineer Office. P4763 A

WANTED, Experienced MACHINERY SALESMAN for India by Calcutta Firm of Engineers. Public school boy preferred. Five-year agreement. Pay commencing Rs. 600 a month. No married men will be considered.—Write, Z. A. 571, c/o Deacon's, Leadenhall-street, London. 7216 A

WANTED, Experienced MAN to REPRESENT, in London, FIRM of BOILERMAKERS and HEATING APPLIANCES. Good address and first-class qualifications essential. Town office and staff provided.—Apply to Secretary, HARTLEY and SUGDEN, Ltd., Halifax. 7201 A

WANTED IMMEDIATELY, a Young, Thoroughly energetic MAN to Act as Assistant Rate Fixer in all departments of large Rolling Stock Works in Yorkshire. This is an excellent opening for a young man, and preference will be given to one who has had experience in estimating and costing of rolling stock work. Permanent situation and good salary for the right man.—Address in the first place, stating age, experience, and salary required, P4796, The Engineer Office. P4796 A

SITUATIONS OPEN (continued)
Page II.

SITUATIONS WANTED, Page II.

MACHINERY, &c., WANTED
Page II.

FOR SALE, Pages III., IV. and VIII.

AUCTIONS, Page XCVI.

PREMISES TO LET OR WANTED
Page III.

WORK WANTED, Page VIII.

AGENCIES, Page II.

MISCELLANEOUS, Page II.

For Advertisement Rates See Page 103, col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page XCV.

SITUATIONS OPEN (continued)

APPLICATIONS are INVITED for the POSITION of ASSISTANT POWER and ELECTRICAL ENGINEER. Applicants must be experienced in the Erection, Maintenance, and Repair in connection with Engineering Works Electrical Equipment, and must have had first-rate experience with Boiler and Engine-house Plant. Application should be made by letter, stating experience, age, and salary required, and enclosing copies of three recent testimonials.—Address, P4794, The Engineer Office. P4794 A

ENGINEER REQUIRED for Estimating and Negotiating Contracts and carrying these through to completion. Public school and University man preferred. Practical training essential and some knowledge of design of centrifugal and turbine pumps desirable. Should be experienced and competent salesman with good connection, whose chief duties would be to promote energetically the sale of machinery of this character.—Apply, giving full particulars, with age and salary required, to W. H. ALLEN SONS and CO., Ltd., Queen's Engineering Works, Bedford. 7198 A

ENGINEER, with Good Practical Experience in the Maintenance of Printing Machinery and Plant (mechanical and electrical), REQUIRED for large modernised London printing works. Must have first-rate administrative qualifications, be used to handling men and be conversant with the ordering and care of stock and stores. Candidates are required to write, giving concisely their qualifications, age and salary, and particulars of the last two posts held by them.—Write, Box No. 867, Bernell's, 44, Chancery-lane, W.C. 2. 7265 A

GENERAL MANAGER WANTED IMMEDIATELY. Competent to take charge of engineering works specialising in gas works plant. Must be fully qualified engineer, thoroughly conversant with modern requirements of gas works and similar machinery. Liberal salary to first-class man.

Applicants must state (in strict confidence) age, present position, qualifications, when at liberty, and salary required; also enclose with application copies of not more than three recent testimonials.

Address, P4742, The Engineer Office. P4742 A

MALLEABLE IRONFOUNDERS (Staffordshire) REQUIRE COMMERCIAL MANAGER with expert knowledge and good connection.—Address, P4756, The Engineer Office. P4756 A

MESSRS. RANSOMES and RAPIER, Ltd., REQUIRE the SERVICES of a practical WORKS CHEMIST and METALLURGIST, for their works.—Apply, stating full particulars, experience, salary required, &c., to Waterside Works, Ipswich. 7259 A

REDBOURN HILL IRON and COAL CO., Ltd., REQUIRE a thoroughly practical MAN as CHIEF WORKS ENGINEER. He must be capable of Taking Charge of All Plant of a large Blast Furnace and Steel Works, including Coke Ovens and Ore Mines, &c. Must be energetic and a conscientious worker.—Applications, which will be treated in strictest confidence, should be marked confidential and state age, experience, where employed and salary required, to the SECRETARY of the Company, Frodingham, Lincs. 7272 A

REINFORCED CONCRETE ENGINEER REQUIRED by a Firm of Contractors, experienced in Designing all classes of Reinforced Concrete Work without regard to any particular system. Must take responsibility for his designs. Experienced also in estimating and able to show that works have been carried out within his estimates. One who has a connection and who is accustomed to interviewing clients preferred.—Reply, giving age, experience, education and nationality, also stating salary expected, to "CONTRACTOR'S ENGINEER," Box 144, c/o W. H. Smith and Sons, Strand House, Portugal-street, W.C. 2. P4792 A

REINFORCED CONCRETE.—WANTED for Reinforced Concrete Specialists and Contractors in India, ASSISTANT ENGINEER; must have sound technical training with experience in design and construction. Write, stating full particulars and qualifications, age, &c. Liberal terms for good man.—C. L. 621, c/o Deacon's, Leadenhall-street, London. 7240 A

REQUIRED, a SPECIALIST DESIGNER, with wide experience in Reinforced Concrete; speed and accuracy essential; state age, salary, and experience.—Address, 7242, The Engineer Office. 7242 A

REQUIRED by Large Manufacturers of High-grade Steels, BRANCH MANAGER for each China and Japan. Must have had several years' experience in these countries.—Reply, stating fullest particulars as to age, experience, and salary required, to FOLDI STEEL COMPANY (England), Ltd., 156, Caledonian-road, London, N. 1. P4784 A

THE FUEL ECONOMY COMMITTEE of the FEDERATION of BRITISH INDUSTRIES has been requested to RECOMMEND a BOILER-HOUSE SUPERINTENDENT for an important brewery in the London district. Applicants must have had experience in the supervision of Lancashire Boilers and the control of firemen and be competent to make the tests necessary to ensure efficient working.

Replies, stating age, experience, and salary required, should be addressed to the Fuel Economy Department, FEDERATION of BRITISH INDUSTRIES, 39, St. James's-street, London, S.W. 1. P4761 A

TRAFFIC MANAGER REQUIRED.

THE SAMUELSON TRANSPORT CO., of 81, Pare-street, Westminster, S.W. 1, are prepared to receive APPLICATIONS for the POSITION of TRAFFIC MANAGER to the Company.

Applications must be made in writing and be addressed to the Secretary, Messrs. SAMUELSON TRANSPORT CO., Ltd., 81, Pare-street, Westminster, S.W. 1 (envelope to be marked "Traffic" in top left-hand corner).

(1) The position offered is a progressive one.

(2) Unless intending applicants have had previous experience of passenger transport work or traffic management in general it is useless applying.

(3) The man who is not afraid of work and is able and willing to carry out the duties satisfactorily will be welcome and will be well paid.

(4) Salary will depend entirely on the qualifications and experience of the applicant.

(5) We appreciate these are not many men who can satisfactorily fill this post, but to the right man we are prepared to pay the right salary.

The applications must bear the following particulars:

(a) Age.
(b) Particulars of education.
(c) Whether married or single.
(d) Full particulars of experience, where gained, and actual duties undertaken. Previous references (copies only) should be sent.
(e) When at liberty.
(f) Salary required.

Applicants will please note that no appointments for interviews can be made or any inquiries be answered by telephone. Interviews will be arranged solely on the information given in the applications. To the right man the position is a progressive one, and it rests with the person appointed as to what his future salary will be. Proved ability will be paid for. 7275 A

WORKS MANAGEMENT.—WANTED, TWO Qualified ASSISTANTS, with first-class practical and theoretical experience: (a) one for the Manufacture of Generators, Turbo-alternators, Motors, &c.; and (b) one for Steam Turbines, Condensers, Pumps, &c. Applications are invited from men with a thorough knowledge of the manufacture of the apparatus mentioned, and only those who have exercised executive control in an engineering works need apply. Applicants must be of good personality and familiar with the most up-to-date methods of manufacture. Applications (which will be treated in confidence) should give full details of experience, positions held, and qualifications for the vacancies, and should include age of the applicant and salary required. The positions offer excellent prospects to suitable applicants.—Address, 7281, The Engineer Office. 7281 A

SITUATIONS OPEN (continued)

WANTED for Abroad, for About One Year, LEADING ENGINEER DRAUGHTSMAN, capable of taking in hand arrangements of machinery and details for light cruisers and destroyers, also the design of machinery for small craft, such as tugs, ferries, &c. —Address, giving age, experience, and copies of testimonials, 7259, The Engineer Office. 7259 A

WANTED, JUNIOR DRAUGHTSMAN for Diesel Engineer's Office; one with some experience preferred.—Address, stating age, experience, and wages required, P4806, The Engineer Office. P4806 A

CONSTRUCTIONAL DRAUGHTSMAN REQUIRED. Must be reliable man, efficient in detail and design, able to see jobs through from start to finish. State age, experience, and salary required.—Address, 7289, The Engineer Office. 7289 A

DRAUGHTSMAN, AERIAL ROPEWAYS.—First-class MAN WANTED, accustomed to Preparing Schemes and Tenders.—Apply, stating age, experience, wages required, when free, to Chief Draughtsman, JOHN M. HENDERSON and CO., Aberdeen. 7283 A

DRAUGHTSMAN REQUIRED for Jigs and Tools in connection with Steam Turbines, Reciprocating and Diesel Engines, by engineering firm on North East Coast. Applicants must have had experience in working to fine limits on above work and up-to-date methods in economical production. Please state age, salary required, and past experience.—Address, 7254, The Engineer Office. 7254 A

DRAUGHTSMAN REQUIRED for Rubber Works, Middlesex. Good plant and general experience necessary. Write, stating full experience, age, and salary required.—Address, P4770, The Engineer Office. P4770 A

SENIOR DRAUGHTSMAN, Accustomed to Compressors and Air Brake work. Must be good mechanical man.—Address with full particulars, 7182, The Engineer Office. 7182 A

ESTIMATING CLERK for Constructional Steel Work. Able to read drawings and take off quantities; must be quick at figures. State age, experience, and salary required.—Address, 7290, The Engineer Office. 7290 A

SITUATIONS WANTED

ADVERTISER (35) SEEKS POSITION; Experienced switches, crossings, lay-outs, steam, petrol locos., also pumps; 7 years' charge of D.O., 24 charge of small works; good references.—Address, P4798, The Engineer Office. P4798 B

ADVERTISER (23) SEEKS SITUATION, Any Suitable capacity; steam, I.C., and general experience, workshops and drawing-office.—Address, P4777, The Engineer Office. P4777 B

AS Assist. General Manager, Work or Factory Manager, ENGINEER (35) DESIRES progressive POSITION. First-class practical and commercial experience at home and abroad; wide experience mechanical and electrical in shops, D.O., factory maintenance and control. Energetic and hard worker, not afraid to tackle any business proposition. Excellent record.—Address, P4810, The Engineer Office. P4810 B

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 3. 7251 B

CIVIL ENGINEER (33), Graduate Arts Engineering Inst., 1st class degree, honours, 10 years' experience public works, India, survey, design, construction and maintenance canal and drainage works, roads, buildings, shortly retiring Govt. service, DESIRES to hear of suitable APPOINTMENT.—Address, P4787, The Engineer Office. P4787 B

DIE CASTING, PRESSURE AND GRAVITY.—A practical MAN, with wide experience in mould making and casting shops, is OPEN to ACCEPT a POSITION.—Address, P4803, The Engineer Office. P4803 B

ENGINEER, A.M.I. Mech. E., REQUIRES APPOINTMENT, home or abroad; 15 years' practical and theoretical experience of large collieries, design, lay-out, sinking and equipment, &c.—Address, P4765, The Engineer Office. P4765 B

ENGINEER, Mechanical and Electrical, DESIRES ENGAGEMENT; 20 years' technical and commercial experience, 3 years aeroplane design; competent draughtsman; used to control of staff and men.—Address, P4779, The Engineer Office. P4779 B

ENGINEER, Mechanical, Ex-Engineer Officer (Major), A.M.I.C.E., &c., WISHES EMPLOYMENT, technical or commercial. Experienced engineer and surveyor, disciplinarian; could control undertaking or represent one or two substantial firms; good connection South Wales.—Address, P4785, The Engineer Office. P4785 B

ENGINEER, Mechanical (25), B.Sc., A.M.I.C.E., 18 months' experience at home and abroad, pupilage shop trained, drawing-office, supervision new construction, sales and general commercial experience, DESIRES POSITION of responsibility. Disciplinarian, hard worker and used to control. Technical correspondence in French and German.—Address, P4756, The Engineer Office. P4784 B

ENGINEER, 25 Years' Experience, NEEDS EMPLOYMENT, ex-officer, accustomed to mining, milling, mill designing and erecting, &c.—K. C., "Mocharie," Chelmsford. P4780 B

ENGINEER (21), Energetic, A.C.G.I. (University of London), A.M.I.E., SEEKS POSITION; accustomed responsibility; would act as representative, speaks French.—Address, P4769, The Engineer Office. P4769 B

HIGHLY Competent BUSINESS MAN (Presently holding important post) OPEN to NEGOTIATE for POSITION with leading firm. Experienced accountant, extensive commercial training and knowledge, with practical experience in negotiating for and purchasing engineering requisites. Highest references. Interview desired.—Address, P4735, The Engineer Office. P4735 B

M.E. ASSISTANT (Knowledge of Metallurgy) SEEKS POSITION, home or abroad. Sound practical and technical training; willing to travel; tact, initiative and ability.—Address, P4809, The Engineer Office. P4809 B

MECHANICAL and ELECTRICAL ENGINEER, as Assistant in Engineer's Office. Technical or commercial work; good draughtsman, estimator and correspondent.—Address, P4812, The Engineer Office. P4812 B

MECHANICAL and ELECTRICAL ENGINEER (39) DESIRES APPOINTMENT as General or Works Manager where brains, energy and initiative are of value; exceptional experience of mass production, tool design, estimating, costs, &c., and control of large staffs.—Box 483, Hairston, High-road, Goodmayes. P4724 B

MECHANICAL ENGINEER, Late Assistant and chief engineer to well-known companies abroad, DESIRES a POSITION of responsibility abroad or home. Spanish spoken; excellent testimonials.—Address, P4787, The Engineer Office. P4787 B

MECHANICAL ENGINEER (27) DESIRES POSITION, home or abroad; drawing-office and shop experience with large firms; large experience in steam engine design and lay-out of electrical plant.—Address, P4771, The Engineer Office. P4771 B

SITUATIONS WANTED (continued)

MECHANICAL ENGINEER SEEKS Administrative POST. Late general manager; knowledge of supervising all depts., keen organiser, tactful and thoroughly enthusiastic; Aged 41.—Address, P4804, The Engineer Office. P4804 B

MECHANICAL ENGINEER, with Good All-round general experience as foreman, cost clerk and manager, SEEKS responsible POST in any capacity, any district.—SNOAD, 36, York-road, Hitchin. P4795 B

LOCOMOTIVE ENGINEER DESIRES APPOINTMENT, home or abroad; experience in drawing office, shops and running departments; would prefer position with locomotive firm in England.—Address, P4772, The Engineer Office. P4772 B

TO DIRECTORS.—GENTLEMAN (40), M.I. Mech. E., with wide and varied experience in works management, production and general management, DESIRES highly responsible and progressive POST. Capable of relieving a board of directors from many worries and getting satisfactory results. Has successfully controlled work employing 5000 hands and really obtained economic production. Thoroughly versed in sales organisation, estimating and all departments of a successful business. For last three years assistant general manager of a large and well-known firm. Credentials furnished of the highest character. —Address, P4683, The Engineer Office. P4683 B

YOUNG ENGINEER (22), G.I. Mech. E., G.I.A.E., university education, DESIRES APPOINTMENT, any capacity; 2 years' pupilage with well-known firm of general engineers and motor car manufacturers.—Address, P4786, The Engineer Office. P4786 B

YOUNG ENGINEER (23), with 4½ Years' D.O. experience, 2 years' tech. college, first-class diploma in mech. eng., OFFERS SERVICES in return for experience and moderate salary.—Address, P4776, The Engineer Office. P4776 B

A DRAUGHTSMAN, Nearly 30 Years, 8 Months Disengaged, will be pleased to LEARN of a suitable VACANCY.—Address; 5½ yrs. works and 1½ yrs. D.O. with large rly. co.; 3 yrs. motor car and aircraft machine design; 4 yrs. mechanical engineering detail design, cranes, structural and general plant work.—Address, DODDS, 167, Dickenning, Newton Heath, Manchester. P4805 B

DRAUGHTSMAN or ENGINEER, 8 Years' Exper. tech., shops, marine engineer, and D.O., SEEKS POST; special experience in boilers, plant lay-out, pipe work, &c.—Address, P4773, The Engineer Office. P4773 B

DRAUGHTSMAN (23), 8 Years' Experience Works engineers, steam, boiler-house, hydraulics, maintenance, &c., any district.—Write, H. E., 41, Hopestone, West Bromwich, Staffs. P4766 B

DRAUGHTSMAN, Junior (25), SEEKS SITUATION, 5 yrs. D.O., several tech. train., struct. or gen. mech. eng.; highest refs.—Address, P4793, The Engineer Office. P4793 B

DRAUGHTSMAN-MECHANICAL ENGINEER, Experienced man, technically trained, DESIRES POST, marine engineering, steam and oil engine experience.—Address, P4802, The Engineer Office. P4802 B

LADY TRACER and COLOURIST, 6 Yrs. Exp., SEEKS SITUATION.—Write, M. B., 27, Playfield-crescent, East Dulwich, S.E. 22. P4800 B

AS MACHINE SHOP FOREMAN (45), Experienced, or would take any section. Knowledge of planning and rate fixing.—Address, H. S., 14, Rutland-road, Bedford. P4789 B

FOREMAN CARPENTER and JOINER SEEKS SITUATION.—Address, P4762, The Engineer Office. P4762 B

FOUNDRY FOREMAN, Working, REQUIRES BERTH; age 37; entire charge; 22 years' experience, jobbing, loam plate and mach. iron and brass. State wages.—Address, P4801, The Engineer Office. P4801 B

IRONFOUNDRY FOREMAN or MANAGER (36) SEEKS RE-ENGAGEMENT; 20 years' experience, good organiser, mixer, abstainer, and capable of taking sole control; at liberty February 1st.—Address, P4774, The Engineer Office. P4774 B

LOCO. FOREMAN FITTER; 12 Years' Experience railway and steel works, DESIRES CHANGE; age 34.—Address, P4760, The Engineer Office. P4760 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.

46, Watling Street, London, E.C. 4.

Established seventy years.

ACTIVE DIRECTOR REQUIRED, with £2500 to £3000 additional working capital, in an established iron, brass, and gun-metal foundry, electrical and mechanical engineering business, Midlands. Investigation invited.—Particulars from ARNOLD and CO. (London), 144, 145, Cannon-street, E.C. 4. 7278 C

EDUCATIONAL

CORRESPONDENCE COURSES for B.Sc., Inst.C.E., A.M.I. Mech. E., and all ENGINEERING EXAMINATIONS. Special Courses and Single Subjects. Personal Tuition.—Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), Assoc. M. Inst. C.E., M.R.S.I., &c., 8-10, Trafford Chambers, 58, South John-street, Liverpool. Ex.

HOME STUDENTS, London Matric., A.M.I.C.E., and all Institution Exams. Really individual tuition by post at very low fees. Send stamp for particulars.—CONSULTORS, 60, Abingdon-road, Kensington, London, W. P4811 B

INST. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. Telephone No., Victoria 4780. Ex.

PUBLICATIONS.

THE MICROSCOPE, a Simple Handbook, by Conrad Beck. Price 2s. 4d., post free 2s. 10d. Sufficiently elementary for the beginner, with valuable information for the expert.

R. and J. BECK, 68, Cornhill, London. 7170

AGENCIES

AGENCY REQUIRED for Good Selling Steam and Workshop Appliances by old-established engineering company having offices and works in London.—Address, P4778, The Engineer Office. P4778 D

AGENT WANTED for the United Kingdom, for the sale of Formator Threading Tools. Applications from first-class firms only, well connected in the machine line and willing to keep a stock corresponding to the approximate turnover.

Full particulars to
AKTIEBOLAGET FORMATOR,
Stockholm, K. Sweden. P4807 D

AGENT WANTED in Sheffield and Leeds Districts by the ANDERSON-GRICE CO., Ltd., for Cranes, Stone and Marble Working Machinery, Gas Engines and Suction Gas Producers. Applicants must be conversant with modern methods, possess good office facilities, and be prepared to work the ground thoroughly and systematically.—Apply, MANAGING DIRECTOR, Tarmouth Engineering Works, Carnoustie. 7284 D

ENGINEER, A.M.I. Mech. E., With Office in Leeds and covering actively Yorks (W.R.), Derbys., Notts, and N. Lincs, DESIRES OSN or TWO ADDITIONAL AGENCIES which will appeal to contractors, farmers, or County Houses.—Address, P4722, The Engineer Office. P4722 D

EPOCH-MAKING INVENTION.—SOLE AGENTS WANTED for U.K. for lucrative monopoly. Perfect smoke consumer, saves 25 per cent. fuel. Vital for all steam users, breweries, hotels, laundries, locos, and dust destructors. Those with £1000 capital.—Address, E. M. 582, Deacon's, Leadenhall-street, London. 7243 D

FIRM of ENGINEERS' and MANUFACTURERS' AGENTS in Victoria-street, London, extending their business, are DESIROUS of TAKING UP ONE or TWO more AGENCIES (sole preferred) for HIGH-CLASS GOODS in the London area.

Address, P4788, The Engineer Office. P4788 D

MANUFACTURERS! Do You Want to Increase your sales in France? French first-class ELECTRICAL and MECHANICAL ENGINEER is READY to ENSURE your REPRESENTATION.—Write to P. 1236, Agence Vor, 7, Rue de Surene, Paris (8e), France. 7240 D

OLD-ESTABLISHED FIRM of Merchants and Engineers, with wide connection in Industrial North, is WILLING to CONSIDER exclusive REPRESENTATION for first-class Manufactures appealing to the Engineering, Shipbuilding, Building, and Allied Trades.—Address, P4702, The Engineer Office. P4702 D

MISCELLANEOUS

WANTED by a Firm of Engineers Already Manufacturing Engine-room Specialities, the MANUFACTURING and SELLING RIGHTS for America of British or Continental PATENT APPLIANCES used in connection with Power Plants or Engine-rooms of Steamships. Royalty basis preferred.—Address, P4779, The Engineer Office. P4779 I

WANTED, OFFICE ACCOMMODATION.—Consulting Engineer's present lease expiring, requires offices, Westminster. Would share with suitable gentleman general office, waiting room and clerks where separate private offices also adjoin. No partnership. References exchanged. Write his solicitor in confidence; endorse letter "C.E. Offices."—H. C. BARTLETT, Solicitor, 44, Bedford-row, W.C. 1. P4763 I

A FIRM that has been Developing an Important and valuable Machine Tool (for Constructional Engineers, Boilermakers, and Shipbuilders), ranging from 1 ton in weight, is DESIROUS of MAKING an ARRANGEMENT with a larger firm in order to have increased manufacturing facilities and financial assistance in selling on a mutual basis.—Address, P4790, The Engineer Office. P4790 I

A LARGE ENGINEERING CONCERN in the North of England, extremely well laid out for the speedy and economical manufacture of riveted, welded and pressed work on mass production lines, INVITES CORRESPONDENCE from FIRMS desiring to place on the market developed Patents or other Engineering Specialities.—Address, 7111, The Engineer Office. 7111 I

AN Old-established ENGINEERING FIRM in the S. Midlands, engaged on the manufacture of steam machinery up to 100 I.H.P., boiler and structural steel work, is OPEN to MANUFACTURE any similar articles or other Engineering Specialities.—Address, 7234, The Engineer Office. 7234 I

F. C. BARKER, Foundry Engineer and Moulding Machine Production Expert, now OPEN to OFFER EXPERT ADVICE on Production, Equipment, for Large or Small Moulding Machine (all types). Designer of the Rapid Core Plates, 500 to 1000 cores per day, 14in. dia., 6in. h.sg.

Estimates for supplying any shape core or size for repetition work.

Apply, 9, Victoria-terrace, Newark-on-Trent. P4759 I

PATENTS, INVENTIONS, TRADE MARKS DESIGNS. Advice and handbook free.—KING'S PATENT AGENCY, Limited (B. T. King, Director), 146a, Queen Victoria-street, London. 45 years' refs. Tel., Central 682. 7240 I

TO MAKERS OF COAL DRYERS.—PRICES and PARTICULARS REQUIRED for COAL DRYING APPARATUS, capable of dealing with about 20,000 lb. per hour.—Send details to G. G. BELL, Electricity Works, 85, Fulham Palace-road, S.W. 6. 7287 I

MACHINERY, &c., WANTED

WANTED,—
LATHE, 8in. centre, gap bed, screw head preferable.
HIGH-SPEED DRILLING MACHINE.
POWER HACK SAW.
GRINDER (EMERY).
All must be in first-class condition.
Would also PURCHASE MOTORS, 100/110 volt, to drive same.—W. T. WHITELEY, Lower Mill, Longparish, near Whitchurch, Hants. 7290 F

WANTED—2-TON ELECTRIC TRAVELLING CRANE; 1 SET COMPRESSED AIR LOCKS, to suit tunnel about 6ft. diam., either new or second-hand.—KINNEAR, MOODIE and CO., Wheatsheaf Wharf, Rainville-road, W. 6. P4710 F

WANTED, 1200 TONS STEAM INTENSIFIER FORGING PRESS, suitable for slabbing and punching steel tyres.—Address price and full particulars, P4672, The Engineer Office. P4672 F

STEAM ENGINE, Horiz. Compound, Davey-Paxman, self-contained, 8½in. and 16in. 18in. stroke, steel bed, belt fly-wheel 7ft. dia.—Write, J. T. WILLIAMS and SONS, South Bermondsey Station, London, S.E. 16. 7240 F

For continuation of Small Advertisements see page iii

The Maintenance of Tidal Berths.

By ERNEST LATHAM, M. Inst. C.E.

THE maintenance of tidal berths is a subject of considerable importance. There are several factors which are frequently overlooked and form the causes of damage either to the berth itself or to shipping. The subject matter of this article really forms the border line between the functions of the surveyor expert in civil engineering matters and the marine surveyor.

In the case of any berth, careful consideration must be given as to whether or not a jetty, quay, or wharf in a tideway is being constantly damaged, involving considerable expenditure. The cause may often be found in faulty mooring arrangements. Experience has shown that civil engineers in general are not sufficiently acquainted with the technicalities of mooring ships. Whereas it is probably no part of their duty to acquaint themselves with the technicalities of Lloyd's requirements and those of other insurance bureaux, it is desirable that the general aspect of the question should be studied, particularly as to the varying angles of altitude and depression on the different ropes which occur as the ship rises and falls with the tide. This is the great disadvantage of all tidal berths and does not of course occur to the same extent in a dock floatage.

DREDGING AND MAINTAINING BERTHS.

At most tidal quays the ships berthing are either ashore at low water or only *partially* waterborne. Regular inspection, therefore, of the river bed forming the berth is a matter of great importance, and in nearly all cases the berth must have definite attention either by the dumping of small block chalk and levelling or by dredging, dragging, or grabbing. It is remarkable in some riverside trades how rapidly obstructions build themselves up on the river bed. In the case of one large corporation owning several properties on the river Thames, there was reason to suspect that a ship of nearly 6000 tons deadweight had strained herself on a berth, where there were presumed to be about 10ft. of water at low tide. Examination of this berth showed that the craneage facilities did not permit of the ship remaining in one position during the whole period of discharge; further, the berth was of such importance that between 300 and 400 ships visited it per annum, or roughly one ship every other tide. The necessity of putting this berth in sound condition, therefore, was very urgent. Emergency soundings were taken at once, and certain inequalities in the bed of the berth, as also certain isolated patches of hard material, were noted. The surveyor's recommendations were ultimately carried out, and these consisted of dredging the berth to a uniform depth, involving the removal of over 6000 cubic yards of material. A detailed survey was afterwards made which indicated that one of the hard "patches" had not been successfully removed by the dredger. A diver's inspection was made and it was found that this "ridge" or "reef" ran right across the centre of the berth. Arrangements were, therefore, made to break up the hard material, which consisted of ballast "cemented" together so as to have almost the consistency of concrete. The reef was ultimately removed by an improvised rock breaker and by grabbing up the broken material. The reef was approximately 40ft. wide and 50ft. long, and just how it came to be formed was a matter of conjecture.

If local patches of hard material have to be removed it is of great importance to ensure that the excavated level is *below* the general level of the berth, and, if there is no silt or mud travel, the artificial depression so formed must be filled up with clay or other suitable material. A common mistake, and frequently an expensive one, is to dump chalk or soft limestone in large fragments in a haphazard manner and with no proper attempt at levelling the berth afterwards. The motor schooner Clarita was recently damaged at Odams' Wharf on the Thames-side; in this case the damage necessitated the ship being run ashore shortly after starting, and it was not possible for the wharfingers to put forward a really sound defence.

Although there are exceptions, as a general rule a wharfinger has to provide a fair berth. In the case of a damaged ship the legal aspect is somewhat complex and uncertain. On a vessel being found to have sustained bottom damage, it is frequently assumed by the owners that this has been caused by the last "dry" berth occupied by the ship. This was the case made by the owners of the ss. Irkutsk against Hayes Wharf, London Bridge, in 1909. A complete survey of the berthage was made, which revealed nothing of a nature to account for the extensive damage to the ship. The ship was new, double-bottomed with closely spaced diaphragm plates, being specially designed for taking the ground. The outer skin of the ship was badly set up and numerous diaphragm plates buckled. In this case the wharfingers stoutly denied the suggestion of a foul berth, and it was ultimately ascertained that the ship had suffered damage elsewhere. This is the class of case which the maritime engineer is often required to deal with, and the problems presented must be approached with care.

In the case of alleged damage to a ship through taking the ground there are two main points to bear in mind:—

(1) Was the ship of suitable design to occupy a dry or partially water-borne berth?

(2) What was her exact location on the berth, and was there any corresponding hard obstruction on the bed, which could in any way have caused the alleged damage?

As regards (1) this should be at once cleared up by a survey of the ship, and it cannot be too clearly emphasised that this is a matter for a naval architect or marine surveyor, and does not fall within the province of the ordinary surveyor or civil engineer. As regards (2) it is seldom the *exact* position can be obtained. The author is only aware of one firm on the river Thames, *i.e.*, the South Metropolitan Gas Company, which actually charts the position of each ship berthing—a most desirable thing to do. If the berth is entirely dry at low water a careful inspection can be made, and it is essential to go over the berth with an iron probe. If the berth is not dry, soundings must be taken and a diver should, in addition, be sent down. The position of any sounding or level taken must always be accurately defined with regard to the shore line as, in the event of litigation, the ability to vouch for accuracy of "position" is equally important to both sides in establishing the "facts." The frequency with which cases of damage to shipping occur through ships taking the ground at tidal berths is in itself the strongest recommendation in favour of periodic surveys.

FENDERING.

One of the biggest problems of maintenance is presented in the ever-recurring damage to fendering, and the whole subject really merits much more consideration than it has been hitherto accorded by civil engineers. The fendering of tidal berths is divided into three classes, viz.:—

(1) The fendering on the face of a solid masonry concrete, brick, or close-timbered quay face.

(2) The fendering of an open-piled structure.

(3) The fendering of jetties constructed on the "cylinder" system (*i.e.*, large diameter piers and large spans.)

The first class of fendering calls for little remark and usually consists of vertical timbering at close intervals. The fenders are sometimes faced with half round steel bands similar to a ship's rubbing pieces, and horizontal distance pieces are sometimes provided. As replacement is frequently necessary, bolting through into the quay face should be avoided. When such fenders are carried away by ships or barges the bolts are nearly always bent or otherwise strained, and putting in new bolts to a solid quay face to which there is no access behind is a waste of money and time. Such fenders should preferably be strapped, the strap being designed so as to be considerably weaker than its attachments to the quay face, thus, in the case of damage, ensuring only the failure of the straps which can quickly be renewed.

The second class of fendering is generally most unsatisfactory, and one hesitates to estimate the very heavy annual expense which occurs through fenders being "carried away or displaced." These costs appear to be fairly equally divided in the long run between the wharfingers and the shipowners, but they are a continual source of annoyance to both. The design of fendering for open piled structures on the river Thames—see Fig. 1—is more or less standardised, but it does not appear to be efficient. The fendering is usually in English or American elm and of 12in. by 6in. section, sometimes heavier. The spacing of the fenders is governed by that of the main piles, varying from 8ft. to 15ft. The fenders are generally bolted through the main piles with bolts about 5ft. apart, though in the case of reinforced concrete piles they are sometimes strapped on with steel straps. Opinion seems to be divided as to whether the fenders should be bolted straight or strapped on to the face of the main piles, or whether they should have small distance pieces about 6in. thick at each level where the bolts or straps occur, leaving the fenders elsewhere clear of the main pile. The writer is in favour of the fender either coming right against the face of the main pile or having continuous packing behind it. Failure occurs nearly always in the same way; a ship, berthing, catches the projecting fendering with the proud ends of her plating or other projections, and the fenders snap off at the weakest points, *i.e.*, at the bolt holes or where recessed to receive the straps. In some cases additional horizontal fendering A, A, shown by the dotted lines in Fig. 1 has been resorted to. This certainty gets over one objection, but, nevertheless, introduces another owing to the liability of projections from the ship catching under or resting on this horizontal fendering as the tide respectively rises or falls. In general, however, the addition of horizontal fendering is to be favoured, and it possesses some value in transferring lateral stresses to the vertical fendering. In nearly all classes of fendering English and American elm is usually employed in this country for fendering open-piled structures in the sea or rivers. Where the landing stage or jetty is constructed in steel a neat arrangement is to insert timber fendering between the flanges of a channel iron which, in turn, may form a principal member of the stage itself or is readily attachable by bolts to the main structure. This method was adopted some time ago on the landing stage of the West Pier, Brighton, and appears to have given satisfaction.

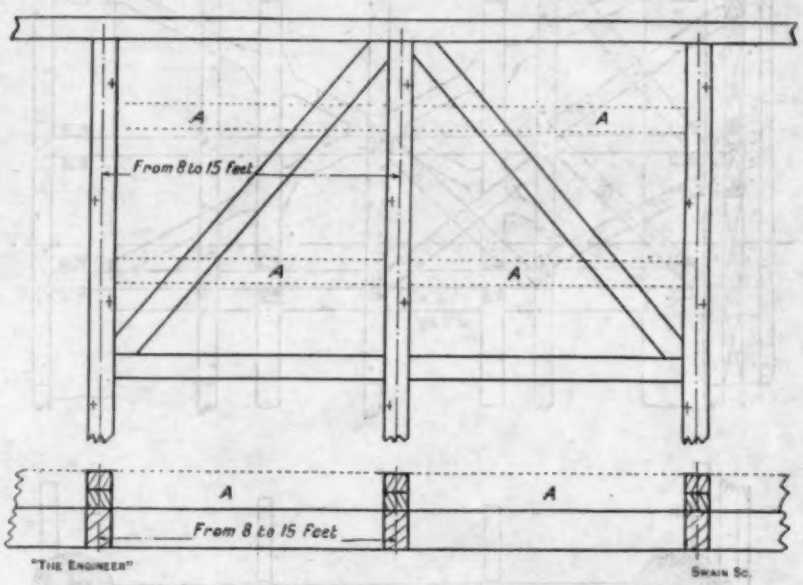


FIG. 1—FENDERING FOR OPEN PILED STRUCTURES

FENDERING CYLINDRICAL STRUCTURES.

The fendering of cylindrical structures presents the greatest problem of all. The writer has experience of three existing cases:—

(*a*) No. 1 jetty head, Thames Haven (London and Thames Haven Oil Wharves, Limited).

(*b*) Coal and coke berths, East Greenwich (South Metropolitan Gas Company, Limited).

(*c*) Jetty of the Imperial Paper Mills, Gravesend.

The conditions at the above jetties are as follows:—

Thames Haven.—Reinforced concrete cylinders, 20ft. centres, protected by timber piles and staging on the face. Ships do not, therefore, come alongside the cylinders. The cylinders are 5ft. diameter, changing to oval section above low water level.

East Greenwich.—Steel cylinders, 53ft. centres, 6ft. diameter. Ships are boomed off by built-up timber booms floating against the face. Ships, therefore, do not touch these columns.

Gravesend.—Reinforced concrete cylinders, 25ft. centres, 5ft. diameter; 12in. by 12in. horizontal timbers are attached to the cylinders at three levels by brackets. In front of these 12in. by 12in. timber piles are driven and bolted to the horizontals with horizontal blocking pieces in the intervals. Elm fenders (12in. by 6in.) are bolted on to the driven piles. This method is really equivalent to putting the face of a timber jetty outside a reinforced concrete structure. This fendering is illustrated in Fig. 2. It is reported on by the resident engineer (Mr. A. Wheeler) as effective but expensive.

Enough has probably been said already to indicate that existing methods of fendering tidal berths leave much to be desired. Experiments with new methods are likely to be expensive, and the civil engineer is naturally shy of recommending this. The author

believes that the best solution will be found to lie in vertical fenders of circular section capable of rotating. They should have a longer life and be much less liable to be carried away.

CONCRETE CONSTRUCTIONS.

Apart from the necessity of keeping the river bottom in good condition and maintaining the fendering, the actual maintenance of the jetty, pier, or wharf, is often neglected, and for the sake of saving a small annual expenditure, a structure in the river or sea has often to be almost rebuilt after a few years neglect. Of late years there has been a growing tendency to construct marine works in reinforced concrete in preference to timber, steel, or even masonry, on the ground of its great durability. The behaviour, however, of reinforced concrete on land is materially different to its behaviour as part of a marine structure, and Mr. L. H. Savile, M. Inst. C.E., gave the experience of the Admiralty in a very thoughtful communication made to the Institution of Civil Engneers at the Engineering Conference, 1921 (Sec. II., Harbours, Docks, Rivers and Canals). He stated that the British Admiralty had experieneed a considerable amount of deterioration in reinforced concrete piers, wharves, &c. One of the most serious facts established by Mr. Savile was that reinforced concrete deck beams well above high water level showed signs of failure and, from photographs produced at the conference, there seems little doubt that reinforced concrete structures require the same periodic inspections as do those of either timber or steel. Colonel Mitchell-Moncrieff, M. Inst. C.E., as the result of inspecting a number of reinforced concrete marine works, has obtained much valuable information as to the poor condition in which these structures are frequently to be found. As regards the normal "decay" of reinforced concrete work, Mr. Savile offers several well-reasoned suggestions as to the causes of disintegration of reinforced concrete in marine works. It is safe to say that his conclusions as to the *porosity* of concrete are probably correct, and, in the case of new construction, rich mixtures of concrete should be adhered to. It is a safe general practice not to permit any weaker mixture than 4 to 1 by volume, *i.e.*, 4 parts of mixed aggregate and sand to 1 part of Portland cement concrete, although, according to the nature and size of the aggregate and sand particles, richer mixtures may frequently be called for. The author is inclined to think that in the case of marine work in reinforced concrete it is desirable to pickle and clean the steel reinforcement before its introduction to the structure.

More importance should be attached to the design of the decking of any jetty, wharf, &c., than is usually the case. In reinforced concrete structures the top skin of the deck should be as nearly as possible an impervious surface consisting of a very dense granolithic mixture or of asphalt. If the deck is practically air and water-tight there will be less chance of "decay" occurring in the deck beams. If an artificial asphalt surfacing is employed, it is important that it should be applied to a rigid specification. In the case of repairing "decayed" or damaged members in reinforced concrete, it should be emphasised that mere surface patching with sand-cement grout is useless, and that the whole concrete, wherever cracking or flaking has occurred, must be cut away for some distance back on either side, and the whole member recast.

DECAY OF TIMBER.

In the case of timber structures in this country decay usually commences in the deck bearers by reason of their holding moisture which runs off from the deck. In the cases of tight jointed decking this decay in the deck bearers is delayed, but the deck itself will suffer. Considerable attention should be paid to the condition of the deck bearers, and sections of the deck should be periodically lifted and the bearers examined. The writer has found that where the deck bearers are only slightly decayed on their upper surfaces a coating of asphalt will prolong life. In all new work it, is highly important to design timber structures so that the deck bearers can be easily renewed without having to dismantle a great deal of the rest of the superstructure. As regards the preservation of timber, there are many trade articles advertised, but experience has shown that careful creosoting with the best creosote oil is so far the best known preservative for such timbers as pitch pine, Oregon, &c. Harder timbers, such as jarrah, karri, greenheart, elm, oak, &c., will not absorb creosote to any extent, and their preservation depends on periodical tarring or painting. Tar or pitch should always be applied hot, and all timbering standing in the sea or river should receive two coats of tar every three years. There are many methods of creosoting:

(1) By allowing the timber to soak in creosote oil.

(2) By carefully drying the timber beforehand and creosoting under pressure.

(3) By putting the timber in a vacuum before and after creosoting under pressure.

A variation of (3) is adopted by the General Post Office in all their specifications. In general it will be found sufficient to creosote timber in tanks under pressures varying from 150 lb. to 200 lb. per square inch. It is equally important to creosote any new piles or members which have to be employed in repair work. There is, too, frequently a tendency to employ new timber in repair work, and to overlook creosoting because the quantity of timber is so small. If all timber is not thoroughly impregnated with creosote or kept well tarred, rapid decay will occur.

The life of steel between wind and water is at least as long as that of timber, probably longer. A great deal of variation occurs in the rate at which steel rusts. In cases in which the structure is not properly maintained by painting or tarring, the variation in the rate of rusting seems to depend on the salinity of the water and the carbon content of the steel. In general, the lower the carbon content the less the rate of rusting, and this is well evidenced by the fact that the tail shafts of ships are usually constructed in wrought iron for the sake of durability. It is essential that steel structures should also be regularly examined and, in general, it will be found that trouble occurs first at the bolt holes, the bolt rusting and becoming smaller in diameter and the bolt hole larger. The joint eventually becomes loose, causing the structure to "work." If this is closely watched and taken in time considerable sums of money can be saved, because otherwise the whole member, which is very often in quite good condition, being only eroded badly at the bolt holes, has to be replaced. In new construction the bolts, nuts, washers, &c., should be clean before assembly, and both the bolt hole and the bolt, &c., thoroughly tarred before use.

In the case of fractured or damaged piles, in order to avoid the cost of dismantling a large portion of the structure, it is often practicable to drive a new pile alongside the old one and bolt or strap the new to the old pile. This cannot, of course, be done in the case of reinforced concrete structures, although it may sometimes be done in the case of steel structures. In the case of wharf walls with a solid fill behind them, if there are any anchor ties the ground round them should be occasionally opened up and these ties examined, as many walls fail by bulging outwards as the ties decay.

It is hoped that one or two useful points may have been brought out in the foregoing notes, but the principal point for the wharfinger to bear in mind is not to go on using a berthage until a serious accident happens, either to shipping or to the structure itself, but to have both the bed of the berth and the structure periodically surveyed and examined by a responsible civil engineer. It is, of course, in the nature of things that the engineer will almost certainly report that certain work is necessary as a result of each inspection, but whether or not any repair work is carried out then rests with the wharfinger. If he does not carry out the work, he, at any rate, knows what the condition of the structure is, and can judge as to its safety and the risks of carrying on without effecting repairs.

The author has known cases in which a jetty or quay has been standing without attention for a number of years, and then some small repairs have at last been decided on. Directly the work of dismantling has been started reconstruction on a far more extensive scale is usually found to be necessary. Needless to say, they have all been cases in which the absence of regular inspection has been either through neglect or an "economy."

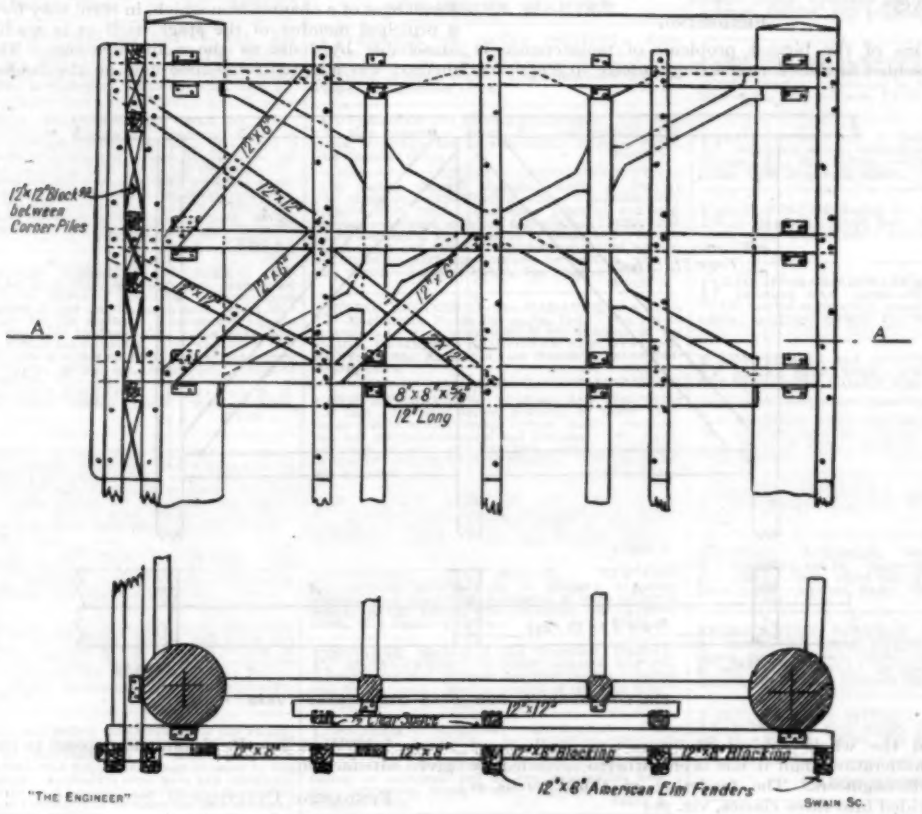


FIG. 2—FENDERING FOR RE-INFORCED CONCRETE JETTY

Sanitary Engineering in 1921.

General Survey.

As in the case of water supply, it can, perhaps, be said that more work was done during 1921 than in 1920, but still nothing like a normal state of things has been reached. Great activity was, however, shown during the year in connection with borough extensions. The cities of Leeds and Bradford both applied for Provisional Orders for extending their boundaries. The Ministry of Health, after local inquiry lasting several weeks, granted a very large extension of each city, and if the Provisional Order passes Parliament this session, Leeds and Bradford will be contiguous with one another with a boundary extending nearly seven miles. Among other borough extension schemes which were promoted and heard include Cardiff, Swansea, Neath, Newark, South Shields, Barnsley, Stoke-on-Trent, Sheffield and Rotherham. All these undertakings will necessitate more or less considerable modifications in the sewage disposal arrangements of the various places.

Both Bradford and Leeds are proceeding with their schemes to effect the purification of the river Ayr, and Leeds hopes to bring a section of its new works into operation during the coming year 1922. Bradford is confining its attention chiefly to the driving of the long tunnel to connect the works at Frizinghall with the Esholt estate, where the big purification scheme and grease recovery plant will be situated. A Ministry of Health inquiry into the application to borrow £1,810,490 in connection with the Esholt scheme was held early in the year.

The work of the construction of the Thurrock Grays and Tilbury joint sewer and purification works proceeded during the past year. Reading made a commencement with the construction of the activated sludge plant which, as we reported last year, has been adopted. Chertsey completed its purification works, which were held up during the war, and a commencement was made with the Swindon sewage purification works. A commencement was also made with the large additions to the Portsmouth sewage disposal works and pumping plant with a view to prevention of flooding, which occasionally now takes place. The West Kent Main Sewerage Board made considerable progress during the year, and about 6 acres of sludge beds were completed. A contract for a river wharf 500ft. long, with approach bridge, tramways, crane track, &c., and a new length of main outfall sewer was let and the work started, and a contract for the screen house, detritus, precipitation and storage tanks, a further length of outfall sewer, offices, stores, and the general lay-out of the site was advertised. Among other works completed or in contemplation may be mentioned the following:—Watford obtained sanction for a loan for the construction of new sewage works and pumping main. The Wandle Valley

Sewerage Board contemplates the expenditure of £300,000 on the reconstruction of the sewage works at Mitcham. Wigan in the early part of the year received the sanction of the Ministry of Health for loans to a total of nearly £145,000 in connection with extensions of the sewerage and sewage disposal works at Pemberton and Hoscar. The Pemberton portion of the scheme is being carried out as a relief work for the unemployed, as also is the work of reconstructing the sewers in the Poolstock and Worsley Mesnes districts. Doncaster proposes to spend £400,000 on its new disposal scheme. The Borough of Hornsey is reconstructing a length of main outfall sewer at an estimated cost of £120,000. St. Albans has had to expend £132,000 in sewering its added area, the estimated pre-war cost of the work being £52,000. Huddersfield intends to extend its tank accommodation at Deighton and to provide additional filters and humus tanks at Cooper Bridge. The Corporation has, we understand, closed down its grease extraction works. Leiston has applied for a loan for outfall sewerage and a surface water drainage system. A Ministry of Health inquiry was held in October into the application of Wakefield for a loan for the purpose of re-modelling the Agbrigg sewage disposal works. The formal opening of the new Ystradgynlais sewerage scheme took place at the beginning of December. In the middle of December an inquiry was held at Jarrow into the application of that town to borrow £60,430 for the construction of a sewer from Monkton along the valley of the Don, with an outfall into the Tyne. The Sheffield Corporation is proposing to convert a number of bacteria beds to the aeration process—referred to in another paragraph—to permit of the treatment of a dry-weather flow of 15,000,000 gallons per day with a maximum of 45,000,000 gallons per day in times of storm. The proposal received the approval of the Ministry of Health during the year.

London Main Drainage and Sewage Disposal.

During the year the laying of a new cast iron rising main, 24in. in diameter, from North Woolwich pumping station to the northern outfall works, a distance of about 1¼ miles, was completed. This work was in connection with the enlargement of the pumping station recently carried out. New machinery was provided for the ss. Bazalgette, one of the six vessels which are occupied in transporting sludge to sea. Extensive repairs to the hull were also found necessary. This vessel, it may be mentioned, was delivered as long ago as 1887, and she has been carrying on the service ever since, having up to the date of being laid off made over 12,000 trips of about 100 miles each. Two important works, the first of several included in a comprehensive scheme for the relief of flooding due to storms, were commenced during the year, and are well in hand. These are the north-eastern storm relief sewer and the improvement of the river Graveney. The first work takes the form of a large sewer from Highbury to the river Thames at Shadwell, a distance of about 4 miles. It varies in size from 8ft. to 11ft. 4in. in diameter, about two-thirds of the length being of brick and the remainder of cast iron lined with concrete. The estimated cost is about £950,000. This sewer will afford relief in times of storm to several important sewers, the course of which it crosses, and can discharge into the river at all states of the tide. The river Graveney improvement is a concrete channel or aqueduct, about 2 miles long, and it is designed to take the place of the natural water-course, which is liable to overflowing in times of storm. During the year, too, progress was made with the repair of some of the older sewers in London, which, after in some cases 100 years of service, show signs of structural weakness. In addition to the foregoing, plans have been prepared, and the construction will be commenced early in 1922, of three more works comprised in the flood prevention scheme referred to above. These include new sewers in Wandsworth and Charlton and a pumping station at Hammersmith, with a connecting sewer. The total estimated cost of these works is £879,000.

Power from Sewage Gas.

During the year a good deal of attention has been paid to the question of obtaining power from sewage gas. The idea is not, of course, new, but interest in it has recently been revived first of all by the activities in this country of the Septic Gas Company of Australia, Limited, and in addition by some experimental work which is being carried on by Mr. John D. Watson, of Birmingham. The company is the owner of patents taken out by a Mr. Flicker, or Walshaw, who was for some time sewage works superintendent at Parramatta, New South Wales. Plants on the Walshaw system have for some time now been in successful operation in various places in Australia. The principle on which they work is that the sewage, after being previously aerated by having air under pressure forced through it, is delivered into a specially designed covered tank, which is furnished with a non-return air valve so that as the gases formed are drawn off air may enter the space above the sewage. Arrangements are made by which, if necessary, the liquid in the tank can be heated. It is insisted upon that the pressure on the surface of the sewage must never exceed, by more than a very small amount, the pressure of the atmosphere, for otherwise foul-smelling gases are produced, and, hence, that the gases must be drawn off as soon as they are formed. The inventor claims that not only does his process produce a greater volume of gas from a given volume of sewage than does any other process, but that the effluent, which, it may be explained, is also aerated just after it has left the treatment tank, is in an exceptionally suitable condition for subsequent treatment, while the sludge is greatly reduced in volume as compared with other processes and is an excellent manure. At Parramatta two 17 horse-power engines have now, for some time—one of them at any rate for several years—been working with the gas produced from ordinary domestic sewage. Apparently there is practically no deposit in the cylinders or valves and the exhaust is described as being absolutely colourless. The methane contents are about 60 per cent. of the total volume of gas and the calorific value is 600 B.Th.U. per cubic foot.

The Watson Experiments.

The experiments which are being made by Mr. Watson at the Cole Hall sewage disposal works of the Birmingham, Tame and Rea Drainage Board, while, to some extent following the lines of Mr. Walshaw's method, actually differ from it in several particulars. Thus, Mr. Watson, instead of feeding his gas-producing tank with sewage, supplies it with sludge which has already undergone a certain amount of sedimentation. Moreover, he does not aerate the sludge before it enters the tank, and he does not provide a non-return air valve of the same type as does Mr. Walshaw, though there is, at Cole Hall, an air relief valve which, however, does not come into operation until there is in the tank a vacuum equal to that represented by 24in. of water. There are other differences between the Walshaw and Watson plants, the most important of which is, perhaps, the design of the tank in which the gas is produced. The Birmingham plant appears to be operating most successfully. The gas obtained is of high calorific value averaging, as the result of the analyses of two samples taken at intervals of about a month, as much as 675 B.Th.U. per cubic foot. It is employed in driving a 25 horse-power gas engine which, in its turn, works a centrifugal sludge pump. The exhaust from the engine is turned into pipes which traverse the treatment tank. It is interesting to note, in this connection, that though the weather was cold at the time when one of the gas samples was taken the calorific value of the gas was higher than that possessed by the gas in the sample taken in warmer weather, which indicates that it is not necessary for successful gas production that the climate should be warm; the warmth essential for the maintenance of the bacterial activity required for gas production can be artificially imparted to the sewage or sludge by burning the gases produced, or even by utilising the heat in the exhaust from the engine. The development of these attempts to produce power from what has, hitherto, only too generally been regarded as a useless by-product will be watched with interest.

The Sheffield Experiments in Sewage Aeration.

Nearly eight years ago Mr. John Haworth, the manager of the sewage disposal works of the city of Sheffield, commenced a systematic series of experiments on the treatment of sewage, and among the methods he employed was aeration. It was while these experiments were in progress that Messrs. Ardern and Lockett, who had been working, we believe, entirely independently, read their paper on "Activated Sludge." Mr. Haworth continued his experiments and kept prominently in view the desirability of doing away with the necessity of forcing air into the sewage under treatment through small orifices, it having been discovered that if such action were necessary the activated sludge method of treatment was impracticable so far as Sheffield sewage was concerned. We have not space here to discuss the full scope of the investigations, but must confine ourselves to stating that among the points made clear were that the air blown into sewage performed two functions, viz., (*a*) the supply of oxygen in solution to maintain biological action, and (*b*) the agitation of the sludge with the liquid. It was further ascertained that the greater proportion of the air was employed for the second purpose—agitation. This led to the idea that possibly the two functions might be separated, the necessary agitation being effected by mechanical means, so that a much smaller quantity of air would suffice. Early in 1916 a tank of 800 gallons capacity was fitted with a paddle stirrer and an apparatus for inducing air mechanically, and it was found that by suitably regulating the revolutions of the paddle, purification could be obtained satisfactorily to the extent of at least three fillings of the tank per day without the use of the aerator. The experiments were successfully extended to tanks of larger dimensions, and in a paper which was delivered at the annual general meeting and conference of the Institution of Municipal and County Engineers in London in June last by Mr. Haworth and Mr. F. W. Hodgkinson, who is engineer at the Sheffield disposal works, a description was given of a unit of considerable size which was built to embody the method of treatment that had been evolved and which was completed in the latter part of the year 1920. The plant comprises an aeration tank, three retention tanks, three settling tanks, a gauging chamber and a motor house. The aeration tank is 201ft. 6in. long by 75ft. 10½in. wide and 4ft. deep below the water surface. It has a capacity of approximately 354,000 gallons, and it is divided into eighteen longitudinal channels 4ft. wide by thin division walls. The channels are rounded at their ends and connected so as to form a continuous channel 3544ft., or nearly three-quarters of a mile, in length. Across the centre of the tanks are arranged eighteen paddle wheels which agitate and circulate the sewage. The mechanical operation of the aeration tank consists in creating rapid surface changes of its contents by means of the paddle wheels, which agitate the liquid and circulate it continuously round and round the channels, the rate of outflow from the tank being governed by the rate at which the sewage is let into it. At 15 revolutions per minute of the paddle wheels a minimum velocity of 1.7ft. per second of the liquid is secured. The tank was filled with sewage on November 4th, 1920, and about 40 tons of sewage sludge and humus collected from contact beds, &c., were thrown in. After about 21 days' circulation the sludge had become matured, and was found to contain ample biological life. On November 26th sewage was admitted, and from that date until the reading of the paper, effluent had been discharged continuously with the exception of a few odd days occupied in minor alterations and adjustments. The dry-weather flow from the Tinsley district is approximately 250,000 gallons per day, about one-third being trade wastes from large steel works, and the remainder domestic sewage. The trade wastes consist chiefly of acid salts of iron in the ferrous condition, iron pickle, cutting compounds from machine tools, slaughter-house waste, and generally traces of oil. All the sewage was passed through the plant briefly described above up to three times the dry-weather flow, the sewage before entering it having previously been passed through a small detritus and screening chamber, and through roughing tanks of 20,000 gallons capacity to remove the heavier solids. The plant during the whole year gave satisfactory results. The purification obtained is described as being beyond reproach, well oxidised and non-putrescible effluents being produced under all conditions. The power used works out, we understand, at about 36 horse-power per million gallons, while the labour, oil, materials, maintenance, &c., cost about £1 per million gallons. Mr. Haworth in referring to this side of the question, remarks that the cost would, of course, vary according to the size of the plant, and that, no doubt, reduction could be made in these figures for plants treating more than, say, 2,000,000 gallons per day. He thinks, too, that economies might also be made by improvements in the plant.

The Activated Sludge Process.

The activated sludge system of sewage disposal continues to be increasingly adopted not only in this country and in the United States, but in the Dominions, in India and in other parts of the world. In England alone Activated Sludge, Limited, has completed the installation of fifteen separate plants with capacities varying as widely as from 8000 to 1,000,000 gallons per day, the combined capacity of all reaching to nearly 2,900,000 gallons of sewage treated in the 24 hours. The company has also several other plants, some of them of large capacities, under construction. Particular interest attaches to the experimental plant which has been laid down by the London County Council at the Crossness outfall, and to the large installation at the Davyhulme disposal works of the Manchester Corporation. The first-named plant has a treatment capacity of 110,000 gallons per day, and it is reported to be giving satisfactory results. The much larger plant at Manchester, which, we understand, has been in full commission since last June, is also said to be fulfilling expectations. The plant, which operates on the continuous flow principle, is designed to treat 1,000,000 gallons of sewage per day. In the annual report for the year ending March 30th last, of the Rivers Department of the Corporation of the City of Manchester, which was issued before the plant had been put fully to work, it was stated that preliminary operations had demonstrated among other things that the design of the plant was satisfactory inasmuch as a self-cleansing velocity could be maintained on the floor of the aeration chamber without the use of an impracticable volume of diffused air.

The research work which had been for some time in progress at the Davyhulme and Withington in connection with the activated sludge process were brought to a conclusion during the year. At the former place the determinations were carried out on an experimental scale in the laboratory, but at the latter they were effected on a working scale, the daily capacity of the works being 375,000 gallons. Speaking of them the report just referred to says that it became evident during the investigations that both methods—the "fill and draw" and the continuous flow—as applied at the two places, "have serious limitations, and that the results obtained must be accepted with some reserve." It is explained that several separate series of experiments were made for periods varying from seven to fourteen days each, and that the results, which are given below, are the average, in the case of the Davyhulme experiments of seven, and of those at Withington of five determina-

tions. The laboratory experiments at Davyhulme were carried out on the "fill and draw" system; the quantity of sewage treated varied from 30 to 200 litres. It was found that there was in each case a loss of nitrogen, due probably to de-nitrification changes during the settlement period. On the average 17.0 per cent. of the total nitrogen of the sewage was recovered in the resultant sludge, or, if calculated on the organic nitrogen of the sewage, the proportion was 59 per cent. The Withington experiments were made on the continuous flow tank in operation at those works and extended over periods varying from a week to a fortnight. Careful measurements of sewage flow and sludge were made and the sewage effluents were analysed. On the average, 2,677,000 gallons of sewage were treated during an experiment. A wide variation in result was obtained, the average showing that 28 per cent. of the total nitrogen, or 72 per cent. of the organic nitrogen, of the sewage were recovered in the resultant sludge. With regard to the process as a whole the report concludes with the following remarks:—"The results so far obtained from the operation of the large scale continuous-flow activated sludge plant are such as to encourage the hope that the process may be applied successfully and economically to the purification of the city sewage in any "future extension of the existing plant."

The Manurial Value of Activated Sludge.

In connection with the investigations which have been carried out concerning the manurial value of activated sludge, the report gives some figures as showing the results which were obtained during the season 1920–21 with growing crops treated partly with ammonium sulphate and partly with activated sludge produced at the Withington works. They are set out in the accompanying table:—

Comparison between the Manurial Value of Ammonium Sulphate and Activated Sludge.

	Barley. Plots. No. 1.	No. 2.	No. 3.	Total.	B'sh'ls per acre.	Straw. Total.	Per acre.	Wheat. Plots. No. 1.	No. 2.	No. 3.	Total.	B'sh'ls per acre.	Straw. Total.	Per acre.
	lb.	lb.	lb.	lb.		cwt.	cwt.	lb.	lb.	lb.	lb.		cwt.	cwt.
Control unmanured	80	72	90½	242½	66.1	2½	34	43	56½	78	177½	44.4	3½	49
Activated sludge, 30 lb. N per acre	103	95½	104	302½	82.6	3	45	59½	70	78	207½	51.8	4	60
Ammonium sulphate, 30 lb. N per acre	100½	84	110	294½	80.3	3½	49	61½	58	77	196½	49.0	4	60
Activated sludge, 60 lb. N per acre	106	100	108	314	85.6	3½	52	62	69	71½	202½	50.6	4½	64
Ammonium sulphate, 60 lb. N per acre	102	104½	100	306½	83.5	2½	41	71½	70½	53	195	48.8	4½	64

The figures, it is remarked in the report are of interest as they confirm the belief that the nitrogen present in activated sludge is in a form readily available for plant nutrition.

Manchester's New Outfall Sewer.

In July, the Manchester Corporation completed the construction of a new outfall sewer which duplicates a previously existing 10ft. diameter outfall sewer running through Trafford Park to the Davyhulme disposal works. The need for the additional sewer had been felt before the war, and, indeed, the work of constructing it had actually been in progress for some time when hostilities commenced. Operations were, however, suspended by order of the Treasury and were not recommenced until some two and a-half years ago. The new sewer is interesting in several respects. It commences—in so far as the work completed during the past year is concerned—at a junction chamber, 98ft. long by 32ft. 6in. wide, where it intersects the older sewer. It leaves the chamber as a circular brick sewer 15ft. 3in. in diameter and proceeds for a length of something over 1200ft. in a straight line to a storm-water overflow chamber where it makes connection with a previously existing 9ft. diameter storm-water overflow sewer leading direct to the Ship Canal. On its way it passes in turn under one of the railways of the Cheshire Lines Committee and the Bridgewater Canal, both crossings necessitating work of a special character. In the first case the number of rings of brickwork was increased from four to five, and in the second, twin culverts 13ft. wide and 9ft. high were substituted for the circular ring. The passing of the canal was effected without interfering with the barge traffic on the latter, work on half the width of the canal being carried out at one time, the construction of cofferdams being necessary in both cases as the work was done in cutting and not by tunnelling. The storm-water overflow chamber is furnished with a storm-water carrier the height of which can be adjusted so that the amount of storm-water which can be discharged—or in other words at what rate of flow of sewage in the sewer it can be made to come into operation—can be regulated. Beyond the chamber the sewer still remains cylindrical, but its diameter is reduced to 13ft. After running for something over 2000ft. in a straight line it is taken through a right angle by means of a bend of large radius, and then, after another 900ft. or so, it again turns through a large radius bend so as almost to regain its original direction. About 500ft. further on the Bridgewater Canal is again reached and at that point there are a penstock chamber and a connecting sewer to make another connection with the old 10ft. diameter sewer. The discharge capacity of the 15ft. 3in. diameter portion of the new sewer is given as being 330,000 gallons per minute, or at the rate of 475,200,000 gallons per day.

The Ær-sed-con Process of Treatment.

In the autumn there was put to work the first example of a system of sewage treatment which embodies some new departures from existing methods. It has been named the Ær-sed-con system by its inventor, Major Hilder Daw. Briefly described, the system of treatment consists of lifting the sewage continuously in small quantities through a small height and only permitting a small proportion, say one-thirtieth part, of the total quantity lifted to go forward into the sedimentation tank, the remainder being allowed to fall back into the storage tank to which the raw sewage is led as produced. In its fall in a cascade the sewage meets with a stream of air produced by a turbine-driven blower and becomes, so it is claimed, so thoroughly aerated that its subsequent treatment is greatly facilitated. The process of aeration is facilitated by the use of an eddy plate arranged in the path of the blast of air, the plate being so shaped that the falling liquid, when it is blown against it, is whirled about. That proportion of the lifted sewage which is allowed to go forward is led into a rectangular tank, which is longer than it is wide, and which has running from end to end of it two sets of division boards, an upper and a lower, which are arranged at angles to one another in such a way that the tank is divided into two parts, and so that the gases arising from the sludge which gravitates to the bottom of the tank are not allowed to pass upwards through the main body of the liquid but are led to a comparatively narrow channel formed between the upper division board and the side of the tank. The settled sludge is led through two openings into a separate sludge chamber, the openings being furnished with valves so that when the latter are closed the sludge chamber can be emptied without interfering with the liquid in the main tank. The effluent from the sedimentation tank flows out into a channel whence it falls into a tilting distributor which alternately feeds one or the other of two ordinary percolating filters. No secondary filters are employed. The distributor is furnished with a patented device for timing the rate of tilting so that adjustments can be made for varying strengths and characters of sewage. As we saw the plant in operation it was working well and producing an effluent which gave an exceedingly good analysis. A noticeable feature was the entire absence of smell in every part of the plant.

The *Achorutes Viaticus*.

Some interesting experiments were carried out during the year by Mr. F. W. Harris, F.I.C., the Glasgow Corporation chemist and city analyst, in connection with the activities as sewage filter-bed material cleansers of the small insects known as the *Achorutes Viaticus*. As was mentioned in our Annual Article of two years ago, the important part played by this minute insect was the joint discovery of Mr. H. D. Bell, who is the manager of the Stratford-on-Avon sewage works, and Dr. W. H. Parkinson, the medical officer of health to the Basford Rural District Council. The first publication of the outcome of the investigations of these two gentlemen was made in a series of articles which appeared in the columns of our contemporary, *Municipal Engineering and the Sanitary Record*, the series afterwards appearing in book form. Having read the book, Mr. Harris determined to try the effect of inoculating the filter beds at Glasgow with *Achorutes Viaticus*, and he accordingly obtained from Mr. Bell a supply of the insect, with which experiments have been carried out throughout the year not only in two specially designed filters of small size but on the actual beds. As a result, Mr. Harris has evolved a method of inoculating the beds, which is extremely simple, and with which, we understand, success is almost certain of achievement. We shall have pleasure in referring to his method in greater detail in a future issue. He is enthusiastic over the results he has achieved during the past year, and especially, apparently, during the last few months of it, and he expresses the opinion that "the full value of these insects as sewage cleaners has, up to the present, not been properly appreciated."

Straw Filters for Sewage Purification.

One of the papers which was read before the Engineering Conference convened by the Institution of Civil Engineers was entitled "Straw Filters for Sewage Purification." It was prepared by Messrs. Eric Hannaford Richards and Michael George Weekes, and described some experiments which had been carried out in connection with the Rothamsted experimental station to ascertain whether straw would separate the nitrates from a liquid containing them, and whether the product would form a useful manure. A solution of ammonium carbonate, and also urine and cookhouse and ablution shed water from a camp of 300 navvies, were passed through specially constructed straw beds. In both instances the nitrates were successfully abstracted. In the case of the camp, which was at Wainfleet on the Wash, it was found that, whereas, originally the total nitrogen in the straw was only 0.50 per cent. of the dry matter, the nitrogen content of the material taken from the bed after the liquid had been allowed to pass through it for some time was as much as 1.62 per cent. of the total dry weight. Moreover, after storage for six months that percentage had risen to 2.06 per cent. The manure so produced after being kept in a heap at the side of the bed for that length of time, was found to be of excellent quality and in good condition for applying to the soil. Moreover it had no smell whatever.

New Works at Coventry.

The extensive bacteria bed scheme at the Baginton disposal works of the Coventry Corporation was actually commenced as long ago as the year 1913, but it was delayed by the war and was not finally completed until last May. The undertaking included the construction of twelve circular bacteria beds complete, with a cast iron supply main, a distribution channel, dosing chambers, humus pit, and effluent channels. It was designed to deal with two million gallons of sewage per diem, which is roughly equivalent to two-fifths of the city's daily dry weather flow of sewage. The works, which were so arranged that as each bed was completed it could immediately be put into operation, have, since their completion, been in continuous service and have given universally satisfactory purification.

In April last, work was commenced on the construction of an experimental activated sludge plant with mechanical agitation. The installation, which is capable of treating about 100,000 gallons per day, was completed in July and was immediately put to work. Active sludge was, we understand, quickly produced and the sewage proved amenable to the method of treatment. The experiment has been in continuous operation since the commencement.

The Linden Purification Processes.

The system of purification of liquids, which has been developed by the Belgian engineer, Monsieur Linden, is not a novelty, for it has been in successful operation in Belgium for a good many years now. But it is interesting to note that what we believe to be the first example of it to be installed on this side of the Channel was put to work towards the end of the year 1920 and has, so we understand, since been working well in connection with the purification of a portion of the sewage of an English town. Concerning the technical details of the process as applied to the purification of both sewage and water we hope to refer in a future issue. Meanwhile, it will be sufficient for our purpose to say that its underlying principle is the swift separation of the solids, from the liquids containing them, by means of specially designed decantation tanks or vessels. Among the attributes claimed for the process is its ability to de-water sewage sludge. One of the first applications of the system was at Ghent, where the water supply is obtained from the river Scheldt. That river receives the sewage and trade effluents from numerous towns, including liquors from distilleries, from wool-scouring mills, &c. Normally the water is in such a bad condition that the city authorities are said to have regarded it as impossible of purification. We understand, however, that the Linden process when tried, converted it into potable water of excellent character, and that so satisfactory did it prove that an extension of the original installation was ordered. Lime is used as part of the treatment and in the case of potable water, filtration follows the decantation process. Sewage effluents are, on the other hand, not filtered or otherwise dealt with subsequent to flowing from the decantation tanks.

It has been decided to utilise the water power in the mountains on the Riviera by the erection of a large power station. Sixty million francs will have to be provided for utilising two waterfalls, one at Boucairon and the other at Saint Etienne de Jinée and erecting the necessary machinery. It is quite probable, if this is done, that this district will, in the near future, become an industrial centre, as at Grenoble and other localities in the French Alps, where large manufactories have been developed through the use of water power. It is intended that this new station will supply electric current to Nice and other towns on the Riviera.

1600 B.H.P. Nobel-Diesel Marine Engine.

By GEORGE J. STEINHEIL, B.Sc., M.I.A.E.

No. I.

INTRODUCTION.

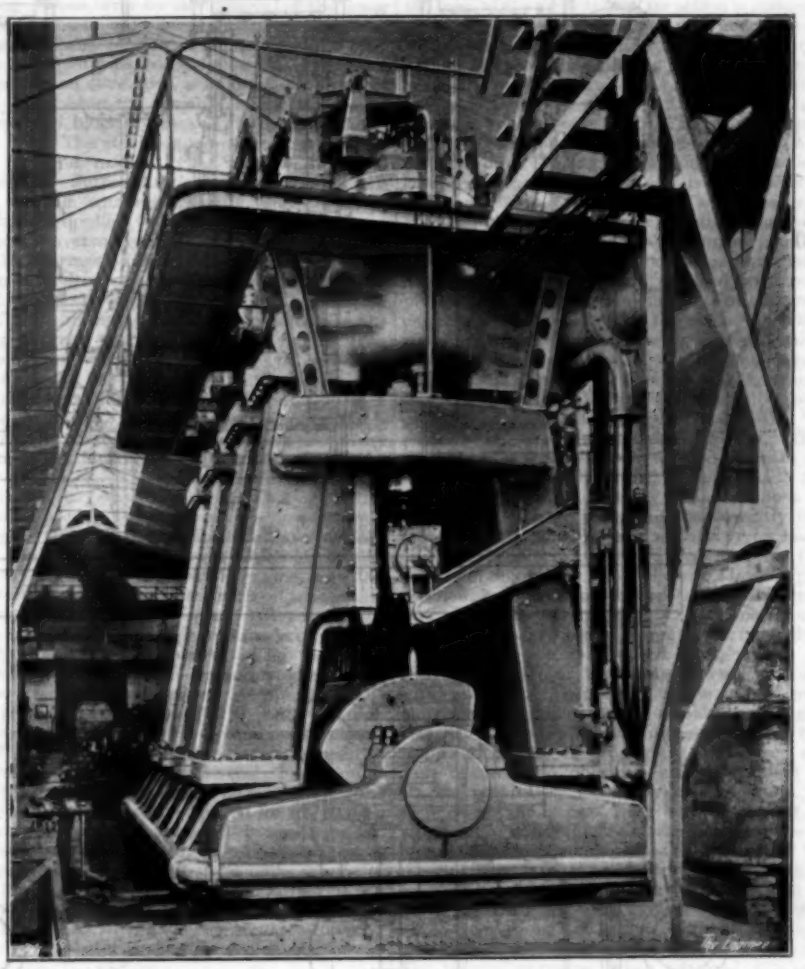
THE above-named engine is the latest product of Svenska Aktiebolaget Nobel-Diesel, Nynashamn, Sweden (the Swedish Nobel-Diesel Co., Limited). The Diesel engine works of this company are situated in the small town of Nynashamn, lying on the shores of a non-freezing bay within 40 miles of Stockholm. The company is a comparatively new concern, founded in 1918, but the origin of the firm has a certain amount of interest attached to it, as it is the direct descendant, so to speak, of one of the oldest Diesel engine makers in the world, i.e., Ludvig Nobel, of Petrograd. The original Russian firm was founded in 1862 for the purpose of manufacturing steam and hydraulic machinery, guns, munitions, machine tools, boilers and fittings, oil-burning appliances, &c. In the late 'seventies of last century a gravity oil burner was introduced by the firm and was particularly suitable for use in smelting furnaces, smith forges and boilers. This burner was adopted as standard by Nobels for their works' forges, and successfully used for forty years. In 1880, the Nobel high-pressure oil burner was placed on the market and eventually adopted by leading Russian steamship companies and railways. It was probably the first oil burner of its type ever made. When Dr. Diesel brought out the Diesel engine in 1897, Nobels took up the manufacture in the same year, thus being one of the first firms in the world to make Diesel engines. The first Nobel-Diesel engine was of the crosshead type, and developed 20 brake horse-power in a single cylinder working on the four-stroke cycle. It was practically a copy of a similar German engine, though it differed in certain minor details, owing to the necessity to meet local conditions. Thus the Nobel engine was designed to work on crude oil, whereas the German engine worked on paraffin. The fuel pumps were therefore dissimilar. Eventually Nobels developed their own designs, differing entirely from those of the Germans. Since the early days a total of over 150,000 brake horse-power of Diesel engines has been built by the Nobel works, comprising seventy-two different types and sizes of four and two-stroke engines for marine and stationary use. L. Nobel, Limited, can claim to have built the first marine Diesel engine in which the speed could be regulated by hand. That engine was a four-cylinder four-stroke set developing 180 brake horse-power at 240 revolutions per minute (D-320 mm., S-420 mm.). Two such engines were fitted in the motor ship Ssarmat of the Nobel Brothers Naphta Production Company in 1904. That ship was an oil tanker of 800 tons deadweight capacity. The leading dimensions were:—Length between perpendiculars, 244ft. 6in.; breadth moulded, 31ft. 9in.; draught, 6ft. She was built at the Ssormovo Shipyard on the river Volga. The engines were direct-coupled to the propeller shafts for ahead running. For going astern they were uncoupled by means of a clutch and ran as generating sets, supplying electric current from the direct-driven dynamos to electric motors on the disconnected propeller shafts and turning them in the opposite direction. This complicated arrangement was necessary, as in those days no direct reversible Diesel engines were available. This system of ship propulsion is known as the Del Proposto system. The Ssarmat is still running with the same engines after eighteen years' service. The first motor ship in the world was also built at the Ssormovo yard in 1903, and was also owned by the same oil company. She was the Vandal, a sister ship to the Ssarmat, only she had a pure Diesel electric drive. The engines of the Vandal, built by the works now owned by the Atlas Diesel Company, Limited, of Stockholm, were of the ordinary four-stroke high-speed stationary type, driving generators supplying current to the electric motors on the propeller shafts. There were three sets of three-cylinder engines developing each 120 brake horse-power at 240 revolutions per minute (D-290 mm., S-430 mm.).

It will not be out of place to mention that practically the whole of the Russian submarine fleet was equipped with Nobel Diesel engines. In 1907 the firm introduced the first direct reversible four-stroke marine Diesel engine. It developed 120 brake horse-power at 400 revolutions per minute in three cylinders. Two sets of such engines were fitted in the Russian submarine Minoga a year later. The question of applying Diesel engines to the propulsion of submarines, especially of early design, required a considerable amount of ingenuity and experience. In those days the submarines were propelled by petrol or paraffin engines, and their replacement by heavy oil engines necessitated the production of a special type of light high-speed Diesel engine, on account of the small space available. To meet these conditions an experimental four-stroke reversible marine Diesel engine was built by Nobels in 1909. It developed 200 brake horse-power in eight cylinders (V type) at 600 revolutions per minute (D–200 mm., S–220 mm.). The weight was only 22 lb. per brake horse-power, thus making it the lightest Diesel engine ever produced. It was fitted into Mr. Ludvig Nobel's motor yacht Intermezzo and thoroughly tested under actual sea-going conditions. From the experience thus gained three types of high-speed four-stroke submarine engines were evolved in 1910 (120 brake horse-power four-cylinder, 160 brake horse-power six-cylinder, 200 brake horse-power six-cylinder), to replace the existing petrol engines in the older Russian submarines.

The problem of the two-stroke cycle was first tackled in 1902, and a year later a 20 brake horse-power single-cylinder crank case compression two-stroke engine was brought out. This engine was of particular interest as it had port scavenging, but the exhaust took place through valves in the cylinder head; it had a scavenging arrangement exactly opposite to that used in modern valve-scavenging engines. The fuel consumption did not exceed that shown by similar-sized four-stroke engines. This engine was used during the Russo-Japanese war to drive the machinery of a munition shop in the Nobel works, and later it was presented to the Petrograd Institute of Technology for experimental use in the engineering laboratory. After that time steady research work was carried out in the experimental laboratories of the Nobel works, and various types of two-stroke Diesel engines with valve as well as with port scavenging were built and tested. As a result of this research work a very successful type of two-stroke submarine engine was brought out in 1914, and with it all the large Russian submarines were fitted during the war. That engine developed normally 1320 brake horse-power at 350 revolutions per minute in eight cylinders. The Nobel Brothers Naphta Production Company gained very valuable experience by the running of its first two motor ships Vandal and Ssarmat. The service results of these two tankers were so good that the company had decided upon the gradual replacement of steam machinery by Diesel engines on all the ships of its fleet, the total tonnage of which amounted to 650,000 tons, including oil tankers of 10,000 tons deadweight capacity. To accelerate deliveries of the Diesel engines, the work of conversion was divided between the Nobel works and the Kolomna works, Golutvin, near Volga (Nobels' licencees for four-stroke Diesel engines). This work was systematically carried out year after year, and it was expected that the conversion would be complete by 1924, but the outbreak of the Bolshevik revolution prevented the completion of the programme. Several slow-speed two-stroke Diesel engines were built by Nobels for Caspian Sea boats, and as their working proved to be very successful, two-stroke cycle Diesel engines were adopted as standard for ship propulsion after 1915.

It is interesting to note that all Nobel-Diesel engines are of the air injection type. The firm holds that with solid or mechanical injection it is impossible to get as good pulverisation as with air injection, and therefore the fuel consumption per indicated horse-power is higher than with the latter. But owing to the absence of air compressors, the mechanical efficiency of the solid injection engine can be made higher, making the fuel consumption per brake horse-power about the same as with air injection. Having tested both systems, the Nobel works found no advantage in adopting the solid injection system, because it does not improve the fuel consumption per brake horse-power-hour. It satisfied itself that solid injection gives imperfect combustion of fuel and therefore produces deterioration of the internal organs of the engine, viz., cylinders, pistons, valves, &c. The Nobel works therefore retained the air injection system, as giving better all-round results, especially as now all compressor troubles have been entirely overcome. By suitably designing the air compressors, scavenging pumps and their drives, the mechanical efficiency of the two-stroke cycle Diesel engines can be made as high as 80–82 per cent., and these are the figures attained in the Nobel-Diesel engines.

Owing to the outbreak of the Bolshevik revolution in Russia, productive work could not be carried on after the spring of 1918. The staff of the Russian works was practically dispersed by that time, as the Bolsheviks had "nationalised" the Nobel works. However, several senior members of the staff, including Mr. Ludvig Nobel himself, managed to escape from Russia into Sweden, and thus formed the nucleus of the management of the Swedish Nobel-Diesel Company, Limited, of Nynashamn. The 1600 brake horse-power Nobel-Diesel to be described below, while being a product of a new firm, actually has twenty-four years' experience of Diesel engine construction behind it.



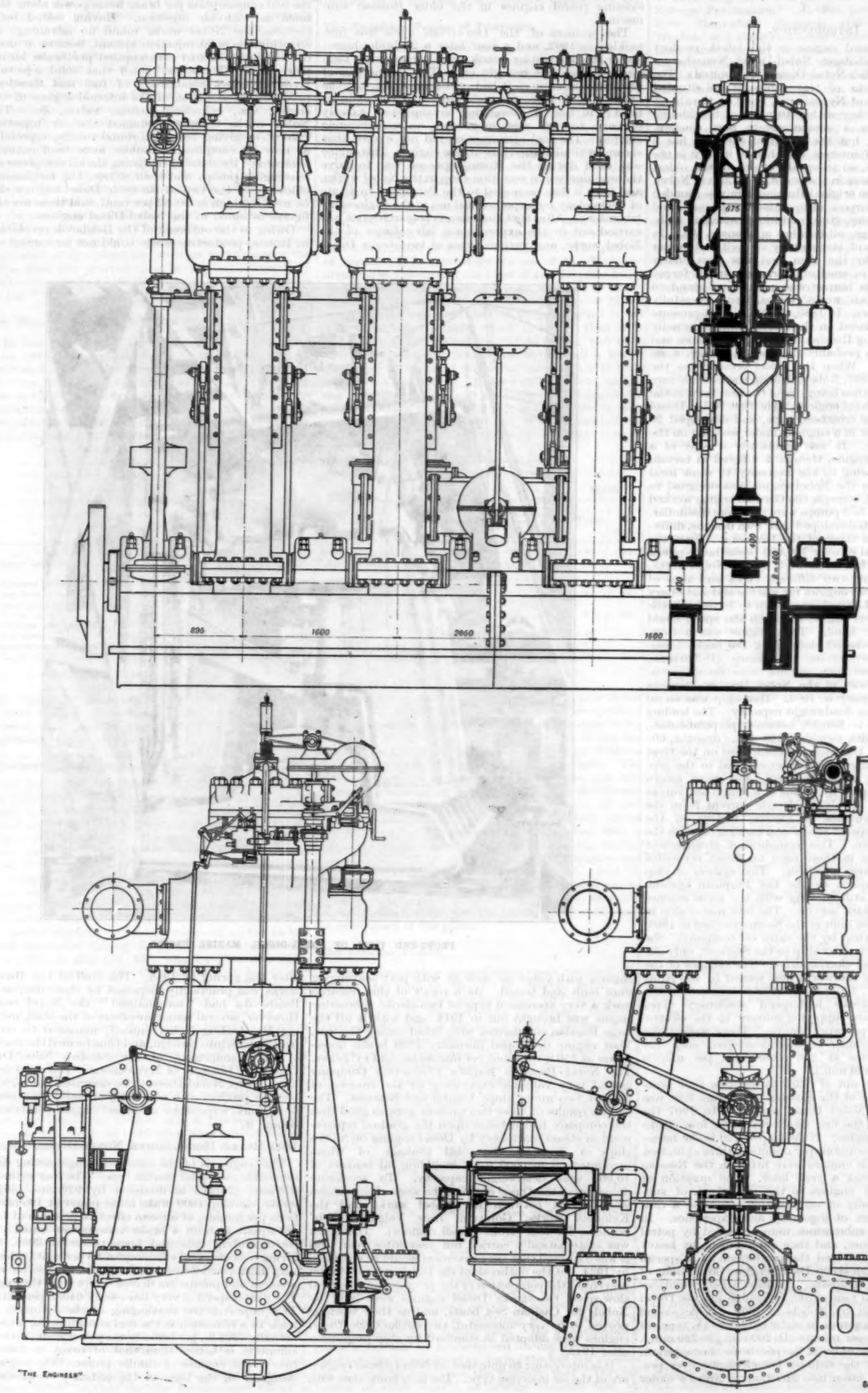
FRONT-END VIEW OF NOBEL-DIESEL MARINE ENGINE

1600 BRAKE HORSE-POWER NOBEL-DIESEL ENGINE.

The engine is of the two-cycle single-acting direct reversible crosshead marine type. The four cylinders, 675 mm. (26½in.) in diameter by 920 mm. (36¼in.) stroke, develop 1600 brake horse-power at 105 revolutions per minute, at a mean effective pressure of 74 lb. per square inch on a brake horse-power basis. The corresponding indicated horse-power is 2000, thus giving a mechanical efficiency of 80 per cent., which is very high considering the fact that all the air compressors and pumps are driven direct from the engine. The piston speed is very low—only 640ft. per minute. This improves the scavenging of the cylinders and leads to a reduction in the fuel consumption, which is actually .393 lb. per brake horse-power hour. This consumption is better than that of many well-known four-stroke engines of similar power. The engine is designed on the lines of the ordinary reciprocating

1600-B.H.P. NOBEL-DIESEL MARINE ENGINE

SVENSKA AKTIEBOLAGET NOBEL-DIESEL, NYNASHAMN, SWEDEN, ENGINEERS



"THE ENGINEER" SWAIN Sc

marine steam engines of the open type with cast iron columns supporting the working cylinders. The single crossheads have their water-cooled guides bolted to the near side columns. The side thrust on the return stroke is taken up by the pads on the opposite side of the crosshead sliding shoe. The parts were so designed as to make their manufacture quite easy and cheap. There are no complicated castings or parts which could not be machined in any ordinary marine steam engine building shop, and therefore any steam engine builder having his shops laid out for the building and erection of marine steam engines of similar sizes can easily undertake the manufacture of the Nobel-Diesel engines, as no special plant and machine tools are required for the purpose.

The most difficult problem in a two-stroke cycle engine is the scavenging of the working cylinder. The usual form of combustion chamber with flat bottomed cylinder head and hollowed out piston top prevents the incoming air from thoroughly scavenging the cylinder. With this arrangement pockets full of exhaust products are allowed to remain inside the cylinder, which dilute the next charge of air and therefore reduce the power output. To counteract this drawback a larger amount of air has to be admitted into the cylinder, this being done by keeping the scavenging pressure as high as 3–8 lb. per square inch. Naturally this leads to considerable mechanical losses due to the power absorbed by the scavenging pumps, which is often as high as 10 per cent. of the engine indicated horse-power. In the Nobel-Diesel engine the design of the combustion chamber has received special attention, and it is such that no pockets can be formed; consequently, far less air is required to scavenge the cylinders. As a matter of fact, the scavenging air pressure in this engine does not exceed 1.6 lb. per square inch at full load, and the power absorbed by the scavenging pumps is 3.5 per cent. of the engine power. One of the outstanding features of the engine is that the columns supporting the working cylinders are all connected together near the top, thus forming a common air receiver for the scavenging air. This arrangement gives a very large receiver without the bulky and unsightly scavenging air pipes running alongside the cylinders. The bracing of the columns at the top adds considerably to the rigidity of the engine, and simplifies the design of the bed-plate, which is of cast iron and in two parts bolted together. Owing to the exceedingly large volume of the receiver and very low scavenging pressure, the fluctuation of the air pressure in the receiver during the working of the engine is practically nil. Scavenging and exhaust take place through ports in the cast iron cylinder liner. The admission of scavenging air is controlled by a cylindrical sleeve valve, actuated from the cam shaft. This valve governs the opening of the inlet ports, which occurs some time after these ports are uncovered by the piston and the pressure of the exhaust gases inside the cylinder has approached that of the atmosphere. The end of the scavenging period is reached when the working piston has covered the inlet ports. The exhaust is regulated solely and automatically by the working piston. The exhaust ports are water-cooled. The controlling of the admission of scavenging air allows a very good scavenging of the cylinder, combined with a long effective stroke. The two double-acting scavenging pumps are placed on the off side of the engine near the bed-plate, and are actuated by links and rocking levers from the crossheads of the two inner cylinders. The diameters of these pumps are 920 mm. (36¼in.), and the strokes 680 mm. (26¾in.). The diameter of the trunk guides of the scavenging pumps is 200 mm. (7¾in.). These pumps have no automatic valves whatever, the suction and delivery of the air being controlled by a patented rotary distributor common to both pumps and driven by skew gearing from the crank shaft at one-third of the speed of the engine, i.e., 35 revolutions per minute. By such means all noise due to the suction of the air and clattering of automatic valves, as well as all valve trouble are, it is claimed, entirely eliminated.

The cylinder heads are steel castings of very simple design, and they are each fastened to the cast iron cylinder jackets by fourteen steel bolts. The lower part of each head which forms the top of the combustion chamber is dome-shaped, this form being found the best to resist heat stresses set up in the head during the working of the engine. Each head contains only three small valves, of which but one is a working valve, the two others being at rest during the running of the engine. This working valve admits the fuel, and is situated in the centre of the head. It is actuated by a bell-crank lever from the cam shaft. The other valves are the starting and the patented combined by-pass and safety valves; they work only when the engine is being started, and when thrown in gear they are actuated by rocking levers from the cam shaft, running alongside the top of the cylinders. It is a notable feature of the Nobel-Diesel engine that the cylinder heads contain neither scavenging nor exhaust valves, and their absence largely accounts for the immunity from trouble with cylinder heads in these engines. The piston head, the top of which is convex, and the piston skirt are separate, but fastened to a common steel piston-rod. The skirt is bolted to the rod at the lower end, thus allowing expansion upwards. To prevent leakage of the scavenging air past the piston, two rings are provided in the lower part of the cylinder. On the down stroke practically the whole of the piston skirt comes out of the cylinder, and it is possible to feel the piston by hand and ascertain whether it is properly lubricated. The piston head is water-cooled.

The crank shaft is of mild steel, and made in two parts bolted together in the middle. Each half is forged from the solid, this construction being considered by the makers to give better results with Diesel engines than the built-up type of crank shaft. The diameter of the crank shaft is 400 mm. (15¾in.), and the weight of it is 13 tons. Each half has two cranks at 180 deg., and the two pairs of cranks are placed at 90 deg. in such a way as to make the order of firing 1, 3, 2, 4. The two parts of the crank shaft are identical, except for the fly-wheel flange on the rear end. Thus it is only necessary to carry the rear half on board as a spare instead of a whole shaft. The engine is so designed that the crank shaft can be removed endwise without dismantling the cylinders and columns. At the rear end of the crank shaft a small fly-wheel is fitted, the weight of which is about 13 tons.

The design of the rocking levers is rather peculiar, as it does not follow the accepted practice of having the pin through the middle of the lever. The Nobel levers have a bearing on the lower side, allowing quick dismantling of each lever by the removal of the lower bearing cap. The links follow standard marine practice. The crosshead block is a solid forging of steel with case-hardened pins bored hollow in the centre. A single crosshead slide shoe is bolted to one side of the block. The piston-rod, which is hollow, is fastened to the crosshead block by means of the usual taper joint and nut. The steel connecting-rods are of the standard fork-end marine type, with white metal lined bearings. Forced lubrication is used for the cylinders and air compressors only, the oil under pressure being supplied from mechanical lubricators driven from the cam shaft at the near side of the engine. All bearings and crosshead guides are lubricated by gravity drip feed, the sight feeds being placed on the off side of the engine near the top. A certain amount of pressure due to the head is available in the oil passing through the bearings. The engine base forms a collector for used oil, which can be used over and over again for the lubrication of these bearings, provided it is well filtered before it is pumped back into the service tank. The blast and starting air is supplied from two tandem air compressors driven by links and rocking levers from the crossheads of the two outer cylinders. The normal blast pressure at full load is 800 lb. per square inch. One of the air compressors contains the high and the low-pressure stages, while the other contains the intermediate stage and the auxiliary unit, from which air can be taken for the working of the steering engine, whistles, &c. Intercoolers of large surface, with oil separators, are provided between the stages. All compressor valves are of the light ring type and made of rustless steel. They are interchangeable. The diameters of the low, intermediate, high-pressure stages and of the auxiliary air compressor are:—540 mm. (21¼in.); 250 mm. (10in.); 110 mm. (4¼in.); and 375 mm. (14¾in.) respectively, while the common stroke is 570 mm. (22½in.). There are five water pumps, all driven from the air compressor levers. The annular valves of these pumps are of gun-metal. Two of the pumps are used for the water required for the cooling of the cylinders, air compressors and crosshead guides, while two similar pumps can be used as bilge pumps or for other purposes. The four pumps have a bore of 125 mm. (5in.) by 360 mm. (14¼in.) stroke. The fifth pump is a special pump for piston cooling, and it is of equal bore but with a shorter stroke—160 mm. (6¼in.) Only sea water is used for the cooling of the engine, including the pistons.

The question of cylinder and piston cooling of large Diesel engines requires very careful study on the part of designers. With the ever-increasing cylinder dimensions it is more and more difficult to cool the joint between the top of the cylinder liner and the water jacket. The makers of the Nobel-Diesel engine, however, have produced a satisfactory cooling arrangement for this joint, which is patented in all countries. The piston-cooling gear is of the grasshopper link type, this being considered to give better results than the telescopic type used in engines of earlier designs. The joints of the links prevent any leakage of water into the bed-plate of the engine where it could get mixed with the lubricating oil. A similar type of cooling gear was fitted to the large submarine Nobel-Diesel engines, and it successfully withstood the rough usage of war. The cooling water for the piston head is led through the cooling links into the hollow pin of the crosshead and thence round a vertical pipe inside the piston-rod to the top of the piston head. The return journey of the cooling water is made in a similar manner, but the water passes through the vertical pipe in the piston-rod. This arrangement always assures a continuous supply of cooling water to the piston top. The fuel for the cylinders is supplied by four fuel pumps, driven from the vertical shaft at the rear of the engine by an excentric. Each cylinder has its own fuel pump, and the amount of fuel delivered by the latter is regulated by the closing of its suction valve. Means are also provided for the priming of the fuel piping by hand before the start. To prevent racing of the propeller in a heavy sea, the engine is fitted with a centrifugal governor, which comes into action as soon as the engine has reached its maximum allowable speed, which is about 130 revolutions per minute. The engine can easily be started from cold, and the air required for the purpose is brought to a minimum, thus avoiding the necessity for high-pressure bottles of large size. The method of starting is as follows:—The starting and by-pass valves are put in gear, and the air is allowed to enter a cylinder at the right moment and to drive the pistons downwards. During the upward stroke the by-pass valve opens and the air inside that cylinder is by-passed into the air receiver, instead of being compressed as is usually done. The scavenging air pressure then rises to normal, allowing the cylinders to be put on fuel much earlier than would otherwise be possible. A similar process goes on in all the other cylinders until the engine is started. As there is no compression inside the cylinders when running on air, the engine speeds up quickly and consumes little starting air. The pressure of the air does not exceed 350 lb. per square inch, and even with a pressure of 100 lb. per square inch the engine can easily be started from cold. Between the air bottles and each pair of cylinders is interposed a manœuvring valve, actuated from the starting lever. This valve does away with all hand operation of large and heavy stop valves on the air bottles when manœuvring, and dispenses with the man at the air bottles. Its action is instantaneous, and the effort required to put it in gear is practically nil. Starting is done from two levers, each coupled to a pair of cylinders, so that one pair can be put on fuel, while the other is turning the engine on starting air; an arrangement originally introduced by L. Nobel, Limited, many years ago. The starting levers are symmetrically situated near the top middle portion of the engine. Owing to the elongated profiles of the starting cams the engine can be started from any position. Each cylinder has two sets of cams, one for "Ahead" and the other for "Astern" running. All the cams of each cylinder are grouped together, and are able to slide sideways along the cam shaft, when actuated by shifting forks, coupled to a push rod, placed parallel to the cam shaft. The shifting of the cams and the adjusting of the rotary distributor of the scavenging pumps is done by the third hand lever. This lever actuates the above-mentioned push rod and forks. These three levers are interconnected in such a way that the shifting of the cams can only take place when both starting levers are in the "Stop" position, i.e., all valves are out of action. The starting levers can only be moved when the cam shifting (reversing) lever rests in the "Ahead" or "Astern" positions. Springs and heavy parts have been avoided in the manœuvring gear, and consequently it is possible to manœuvre this engine entirely by hand from the upper platform, and there is no necessity for servo motors of any kind. The fuel control lever is placed in a convenient position between the two starting levers and above the reversing lever. By means of it the speed of the engine can be regulated from the maximum to the minimum speed of 25 r.p.m.

The question of balancing marine engines is of vital importance, especially in the case of passenger ships. In this matter the two-stroke Diesel engine is an easier proposition than the four-stroke one; but even with the former the reciprocating masses must be well balanced to obtain a smooth-running engine. In the present engine every pair of crank webs is provided with a cast iron balance weight, bolted to the web. The weights of the links, pumps and air compressors were so chosen as to provide for the best possible balance of the auxiliary gear. Owing to good balancing and efficient combustion the engine can run quite smoothly for long periods at such low speeds as 25 revolutions per minute with all four cylinders firing, a point of great importance in marine engines. For barring purposes, when required, the engine is provided with turning gear, consisting of an ordinary reversible pneumatic drill, driving through spur wheels a worm gear on the crank shaft.

The engine has very small overall dimensions and weight for the power developed. The length, excluding the fly-wheel, is 7770 mm. (25ft. 6in.); width of bed-plate, 3600 mm. (11ft. 10in.); and height from centre of shaft to top of fuel valve, 5900 mm. (19ft. 4in.). This point will be appreciated by shipowners, as the cargo-carrying capacity of the ship can thereby be increased. The weight of the engine, excluding the fly-wheel, is 160 tons, or 224 lb. per brake horse-power, and if a 13-ton fly-wheel is added to the weight of the engine, then the weight per brake horse-power becomes 238 lb.

On page 102 views are given of the engine and its valve gear.

ACCORDING to a report, which was recently issued in South Africa by Dr. Wagner, on the Crocodile River iron deposits, the ore is of great purity and, except for one exposure, is of Bessemer grade throughout, analyses showing from 60 to 69.5 per cent. of iron, from .45 to 6.32 per cent. of silica, and from .006 to .05 per cent. of phosphorus. It appears to be quite free from sulphur. The available reserves of high-grade ore in the area must be very considerable. The stretch of ore exposed on the crest of the northern range on Kwaggashoek has a length of 880 yards, and the thickness of the ore body ranges up to 40ft., probably averaging about 20ft. Assuming that this is the average thickness at the outcrop, and that the deposit is regularly wedge-shaped, and only persists to a depth measured along the dip equal to half its length, then the single stretch of ore would represent some 38,000,000 cubic feet, equivalent to over 4,600,000 long tons.

Electrical Engineering in 1921.

No. II*.

The Institution of Electrical Engineers.

Under Mr. Ll. B. Atkinson's presidency, which terminated in November, the Institution of Electrical Engineers was exceptionally active, and judging from the meetings which have been held since Mr. J. S. Highfield became head of the Institution, there is every prospect of that activity being maintained. The granting of the Royal Charter and the honour conferred upon the Institution by the King becoming a patron were two of the most notable events of the year. The informal meetings, which are still to be held at frequent intervals, also marked a distinct step forward. At all the ordinary meetings instructive papers were read. Towards the end of January Mr. G. A. Juhlin presented what was probably the most important electrical paper of the year, namely, a paper on "Temperature Limits of Large Alternators." Briefly, the author's main object was to direct attention to the fact that whilst it has been proved by scientific investigation and practical tests that mica insulation as commonly used in modern alternating-current generators will withstand considerably higher temperatures than those which were at one time considered desirable and safe, most British manufacturers are adhering to the old temperature limits and are thereby failing to gain the economic advantages which they might otherwise secure. It was suggested that the present practice of measuring the temperature rise should be abolished and instead a maximum total temperature should be worked to, because the average air temperature is less than one-half of the assumed value of 40 deg. Cent., at present adopted for the basis for all temperature measurements. Moreover, as tests have indicated that mica insulation as used on modern alternators will stand a temperature of 200 deg. Cent. without losing its mechanical or electrical properties, Mr. Juhlin contended that it is safe to work machines at a maximum temperature of 160 deg. Cent. if 10 deg. be allowed for inaccuracies in measurement. Another paper which was read during the early part of the year was that on "The Thermal Characteristics of Electric Ovens and Hot Plates," by Dr. Ezer Griffiths and Mr. F. H. Schofield. Had those who discussed the paper confined themselves solely to the paper itself the discussion would in all probability have been an exceptionally poor one, for the paper dealt exclusively with research work. As it was, however, the members were permitted to talk freely about all uses of electricity in the home, and one or two important facts were brought to light. It was freely admitted, for instance, that the electric heating of water still remains an expensive operation. Sir William Noble's paper on "The Long-distance Telephone System of the United Kingdom" was undoubtedly greatly appreciated by telephone engineers, for it dealt fully with present practice in this country and showed the extent to which underground cables have up to the present replaced overhead wires. Mr. Byng's paper, which was read in November, dealt with "Telephone Work in the United States," and, as our readers will no doubt remember, the author showed that such work is carried out much more rapidly in that country than it is here. Mr. Baumann's paper on "Recent Developments in Large Steam Turbine Practice" handled some of the troubles that have been encountered in building machines with capacities of thirty or forty thousand kilowatts, and called for co-operation between manufacturers and users with a view to overcoming the difficulties. There is no doubt, we think, that Mr. Baumann's paper constitutes a valuable contribution to the literature on the steam turbine and ought to assist in minimising such lamentable accidents as have occurred in America. Electricity tariffs were considered in papers read by Mr. J. W. Beauchamp and Mr. J. R. Blaikie. In the former paper it was suggested that the so-called fixed portion of a multi-part tariff should be adjusted in accordance with the kilowatt capacity of the consuming apparatus, its character and the manner in which it is operated. Attention was directed to the desirability of considering houses or blocks of houses as one would consider a factory applying for a supply, as it is in that way possible to gain a clear view of the influence of groups of houses on the load curve and on the mains and what must be charged per year against apparatus and the charge per unit consumed in order that there may be justification for carrying out extensions to mains. Mr. Blaikie's paper, which was entitled "Electricity Supply: Present Conditions and the Hopkinson Principles," pointed out that the Hopkinson principles are still sound and can still be applied if they are brought up to date and made to conform with present conditions. Briefly, the policy which Mr. Blaikie put forward was to divide the consumers into two groups, one consisting of those who require a supply for seven days a week and the other for those taking current for six days. The six-day consumer is, of course, the power user, who buys a large quantity of power every day with the exception of Sunday, whilst the other is the domestic consumer with a relatively small consumption. The cost of supplying current in one case is naturally greater than in the other, and Mr. Blaikie's idea is to adjust the tariffs accordingly, making the fixed charge depend as far as possible on the cost of coal. Moreover, as the coal costs are now a much greater factor in the fixed charge than they were originally, it is proposed to introduce a clause governing that charge and the price per unit in accordance with the cost of coal. A lecture which was delivered before the members of the Institution by Messrs. Alfred Johnsen and Knud Rahbek at the end of May and reported in our issue of June 3rd, gave rise to a good deal of discussion concerning the phenomenon which was described, and although it was claimed that the same effect had been observed before, all electrical experts agreed that the work which these experimentalists had carried out was ingenious and important. Professor E. Wilson's series of lectures on "Magnetic Susceptibility of Low Order" were also of considerable interest, especially to those connected with the separation of minerals and magnetic survey work. Two other papers which were read towards the end of the year are referred to under the headings of "Electric Welding" and "Electric Motors." Valuable papers were also read at the meetings held in various provincial centres, and at those of the Wireless Section.

* No. I. appeared January 20th.

Railway Electrification.

The most heartbreaking task in writing a review of electrical engineering in these days is met with when it comes to dealing with railway electrification. As far as this country is concerned there is little to record, although it appears highly probable that extensive work will shortly be put in hand. The repeated references on the part of prominent railway officials to the urgent need for electrification indicates pretty clearly that the matter is not being overlooked. Apart altogether from the well-known advantages of running trains electrically, such as rapid acceleration and so forth, there is the question of saving coal, which owing to prevailing prices is of far greater importance to railway officials that it was in the past. Before outlining, however, the proposed schemes which were put forward during the year we will consider the work that was actually done. On the London and North-Western Railway the electrification of the Euston to Watford line is being completed. As is well known, the work, which will probably be finished this spring, consists of equipping the up and down steam lines from Queen's Park, where there is a connection with the London Electric Railways, to Euston, and a connection with the North London line at Chalk Farm. The platforms that are being dealt with at Euston are Nos. 4, 5, and 7. Lines connecting the West London Railway and the new electric train shed at Willesden are also being electrified and the work is approaching completion. The rolling stock for working the Euston and Broad-street-Watford services comprises thirty-three motor coaches, thirty ordinary trailer coaches, and thirty driving trailer coaches. All the motor coaches are being built at the works of the Metropolitan Carriage, Wagon and Finance Company, whilst the remaining sixty vehicles are being constructed at the London and North-Western Company's carriage works at Wolverhampton. The stock is similar to that used for the Broad-street, Kew and Richmond services, and the electrical equipment, which is practically identical with that used for the above services, is being supplied by the Oerlikon Company. Each motor coach is equipped with four motors. Normally each motor coach operates with one ordinary trailer and one driving trailer, so as to form a three-coach unit. During the busy hours of the day two such units are coupled together and are worked as a six-coach train. The widening of the section of the London and North-Western Railway between Chalk Farm and Kensal Green, which forms the last part of the electrified line from Euston to Watford, is approaching completion and will probably be brought into use about the middle of the present year. When this work is finished a frequent service of electric trains will be run between Watford and Euston, and with this important addition to the present electric train services from Watford to Broad-street, City, Watford to Elephant and Castle *via* the Bakerloo line, and Broad-street to Addison-road, Kensington, *via* Willesden, passengers residing at Watford and intermediate stations will have at their disposal a rapid transport system to and from all parts of London. Connections will be provided with the tube lines at Euston, with the East of London *via* Broad-street, with the West and North-West of London *via* Willesden, with the South of London *via* Queen's Park and the Bakerloo line to Elephant and Castle, and also with the central shopping and theatre districts at Oxford Circus and Piccadilly Circus.

For the London underground system, the balance of the 100 new cars was delivered to the District Railway. Work was also commenced in connection with the erection of a new central overhaul shop at Acton. New exit stairs from the west end of the Victoria platforms were constructed. Oil buffer stops were also provided at the Mansion House and at Acton Town. The automatic signal work between Euston and Stockwell on the City and South London line was completed. The booking office of the Leicester-square station of the London Electric Railway was enlarged, and the Passimeter system was put into operation on the Kilburn Park station of the Bakerloo line. Two automatic boosters controlled with Entz regulators were installed in the sub-stations which supply current to the Great Western Company's extension of the Central London Railway to Ealing Broadway. These boosters work in conjunction with the traction battery and meet the additional demand arising from increased services without necessitating the running of more machinery in the power-house. Several cranes and lifts were also installed in various parts of the system. During October important proposals were made with regard to the electrification of the Great Eastern, Brighton, and South-Eastern Railways. The directors of the Great Eastern Railway are, it seems, considering the question of applying for the Government guarantee in respect of extensive improvements on their system, and especially at Liverpool-street Station. A sum of some £10,000,000 would be involved, whilst employment would be provided for 5000 men for a period of five years. Plans for the electrification of the lines to Enfield, Palace Gates, Chingford, Ongar, and Woolwich, as well as the main line as far as Broxbourne and the Colchester line to Gidea Park, are under consideration. Certain sections of the Brighton Railway which were about to be electrified in 1914 are, it seems, to be dealt with very shortly. In our issue of November 28th we published an abstract of a report advocating the electrification of the whole suburban lines and subsequently the main lines to Brighton, Eastbourne, and Worthing. A similar report setting forth the proposals of the South-Eastern Company was also issued during the latter part of the year. Plans for the electrification of the suburban area of the line have been submitted to the Minister of Transport, but we believe that the Board has not yet decided to go ahead with the scheme, and whether electrification will be proceeded with or not will depend upon the extent of support received from the Government under its scheme of guarantees. A scheme put forward by Lord Ashfield for the development of London's underground railways is estimated to involve an outlay of £6,000,000 and would, if put into operation, provide employment for a large number of men. It is proposed to extend the District Railway from Wimbledon to Sutton, to provide an additional fleet of omnibuses, and to reconstruct the City and South London Railway by increasing the existing tunnel diameter of 10ft. 2in. to 11ft. 8½in. The present terminus at Euston is also to be joined up with Camden Town. The Electric Railway Advisory Committee, appointed at the beginning of 1920, issued its final report during 1921, and the 15,000 volt direct-current system was advocated as the standard system in this country.

Water Power.

One of the most important questions which was considered during the past twelve months was the possibility of utilising water power for the generation of electricity. That there is more of this power available in the United Kingdom than was originally supposed is shown by the final report of the Water Power Resources Committee. In Great Britain some 210,000 kilowatts, or about 40 per cent. of the total units generated by steam during 1917–1918, could, it seems, be developed continuously at an economic rate, whilst in Ireland 280,000 kilowatts could be generated. As regards tidal power schemes the Committee recommended that this matter should be studied by a special technical commission, and particularly with reference to the Severn Estuary, in connection with which a considerable amount of information has already been collected and which is believed to present the best prospects of success in comparison with other tidal schemes. The view of the Committee on the future control of water power developments is that either the Board of Trade or the Electricity Commissioners should be charged with the duty of studying, supervising, and promoting the development of all water power, and the department should have the power to make orders conferring on promoters all the powers necessary to carry out schemes.

Electrical Instruments.

Some information concerning electrical instrument developments was given at an informal meeting of the Institution of Electrical Engineers, when Mr. C. L. Lipman, of Nalder Brothers and Thompson, presented a paper dealing with alternating-current instruments. Descriptions were given of power factor meters, frequency meters, and synchroscopes with an improved movement which is devoid of moving coils, is extremely light, and accurate, and calls for a very small current consumption. Nalder Brothers and Thompson also introduced a sensitive relay which is intended mainly for use with the Mertz-Price and similar protective systems. Apart from the fact that this relay is claimed to be insensitive to external vibration, it only requires ·01 volt-ampère to trip it. Another instrument which was described on that occasion is a three-phase voltmeter, which, besides giving the voltage of a three-phase circuit, indicates the direction of phase rotation in the potential transformer secondary and shows when a break in the circuit has occurred or which of the fuses has blown. The failure of any fuse is indicated, irrespective of whether it is

on the high or low-tension side. The instrument has the usual form of scale and may be of the moving iron, induction, or dynamometer pattern. Among other new instruments introduced by the Cambridge and Paul Instrument Company, Limited, is a "remote indicator" for measuring alternating currents at a distance. An accurate indication of the quantity of alternating current passing at any given point is obtained by transmitting a direct current derived from a thermo-couple or bank of couples to the point where the measurement is required, the thermo-couples being acted upon by one or more heaters energised by the alternating current. The measuring circuit is therefore subjected to a continuous electromotive force which is proportional to the square of the alternating current. A very small pilot wire can be used and measurements can be taken on a sensitive direct-current instrument situated miles away from the point where the alternating current is flowing. The scheme is obviously useful in connection with power schemes and in cases in which the output is controlled from one or more centres with distant generating or distributing stations, and where it is advisable to have at the control centres instruments which show the conditions existing at various distant points. A new string galvanometer introduced by the company is a simple form of Einthoven galvanometer constructed on the lines of the instrument developed by Professor Salomonson. The magnification is about 40 at a working distance of 80 cm., which is a suitable distance for photographic purposes. A new string electrometer, with the fibre and all the electrometer mechanism enclosed in brass dust-proof case, which can be used on the stage of an ordinary miscroscope, and with windows at the back and front, was also evolved by the Cambridge and Paul Instrument Company, Limited. Another interesting instrument which emanated from the same source is a disappearing filament pyrometer. It consists of an electric lamp which is in series with a small ammeter, and the leads are connected to a 2-volt accumulator. The observer looks at the hot body through the eye piece of the instrument and adjusts the current through the lamp by means of the rheostat until the top of the filament is of the same brightness as that of the hot body; the temperature of the latter is then read on the ammeter, which is calibrated in degrees Fahrenheit. The standard ranges for the scale are from 700–1400 deg. Cent. and 900–2000 deg. Cent. Still another new instrument introduced by the company during the past year is an electrical portable CO_2 and temperature indicator, which is quite self-contained. The catharometer and filter are inside the portable case, and when it is desired to take readings it is only necessary to connect the instrument up to the flue and connect leads from the thermo-couple to the couple terminals. The gases are drawn up by squeezing a rubber bulb. A switch with "test" "off," CO_2 and temperature position serves for altering the connections to suit the test that it is desired to make.

Switchgear.

A considerable quantity of new switchgear for power stations and sub-stations appears to be under construction at the present time. The British Thomson-Houston Company is dealing with an order for four 22,000-volt, 25,000-kilovolt-ampère generator equipments, and various feeder equipments for the Shanghai Municipal Council. It has also secured orders for thirty 6600-volt switchgear equipments for three sub-stations at Edinburgh and twenty-eight equipments for Manchester. An interesting feature of the latter contract is that part of the gear, which is designed for 33,000 volts, constitutes an outdoor sub-station. Another firm which is paying attention to the design of outdoor switchgear, owing no doubt to the present high cost of buildings, is the Metropolitan-Vickers Electrical Company, which is manufacturing switchgear suitable for all voltages in commercial use. An outdoor oil switch has been introduced by the company to meet the conditions met with in all parts of the world. It is operated by a solenoid, is thoroughly waterproof, and all parts are accessible. Considerable progress has also been made in the design of protective gear. The above company has developed a system which eliminates one of the three relays which are normally used for the protection of generators in accordance with the Merz-Price circulating current method. This new system is claimed to present several important advantages. The gear is said to be much more sensitive than that which has hitherto been employed, and a greater percentage of the generator winding is protected. Moreover, a relay has been devised which has a time element which decreases as the load increases up to a certain point, after which it is substantially constant and adjustable, the upper limit of adjustment being approximately twenty times the time of operation of a modern circuit breaker. The Metropolitan-Vickers Electrical Company has installed a good deal of extra high-tension switchgear in generating stations and sub-stations, including the Jubilee-street station of the Blackburn Corporation. The majority of the really high-voltage equipments installed by this company in these days are of the outdoor type. One of the most important switchgear contracts which the General Electric Company has in hand is the Neasden contract, which was dealt with in our issue of December 23rd, 1921. Another noteworthy contract secured by the company is for some 33,000-volt switchgear for the Gorseinon Electric Light Company. During a recent visit to the General Electric Company's works, we saw a large quantity of switchgear of various descriptions in the course of construction. The McColl biassed protective gear, as described by Mr. McColl in his paper read before the Institution of Electrical Engineers, has been taken up by the company, and is being used in conjunction with the new switchgear which is being built for the Neasden power-house. Much attention was paid during the past year to improvements in mining switchgear. The Electrical Apparatus Company introduced a special relief bolt for holding down the covers of switch cases and other similar arrangements. By the incorporation of a spring washer in each of these bolts, the cover, which is held down by the bolts, is made to act, in the event of an internal expansion, as a relief valve, and the flames or hot gases which escape through the narrow space between the cold flanges of the box and cover are cooled down sufficiently to prevent the ignition of any inflammable gas which may be present in the mine. Much ingenious work relating to the construction of safe mining switchgear was done by Mr. George Ellison, whose works were described in THE ENGINEER of September 2nd, 1921. More recently —see THE ENGINEER of November 25th—we have dealt with some of the latest switchgear introduced by Brook, Hirst and Co., Limited, of Chester; whilst in THE ENGINEER of October 14th we illustrated and described some new central station switchgear supplied by William Pitt and Baring, of Regent-square. In the same issue we also dealt with an ingenious Igranic reclose circuit breaker, which closes itself automatically when the short circuit has cleared itself. Many other switchgear contracts were, of course, undertaken, in addition to those mentioned. At the Bankside station of the City of London Electric Light Company, for example, some notable work is being carried out by Reyrolle and Co., Limited, who are also installing switchgear in the new Bargoed power station of the Powell Duffryn Steam Coal Company, Limited.

Cables and Transmission Lines.

In his presidential address before the Institution of Electrical Engineers, Mr. J. S. Highfield referred to the importance of reducing the cost of transmitting electricity, and pointed out that the cable makers had succeeded, despite increased costs, in improving the design of cables so as to transmit electricity at a cost little more than that which prevailed before the war. The greater facilities for overhead lines given by the Electricity Supply Act should, he thought, give opportunities for providing electricity in many districts which could not be served by underground cables. There is no doubt that in the near future transmission lines will be employed in this country to a much greater extent than they have been hitherto. One firm, British Insulated and Helsby Cables, Limited, erected during the year over 30 miles of 33,000-volt overhead lines. Other work undertaken by this firm included the laying and jointing of over 30 miles of 33,000-volt three-core cables, and a large amount of work for the British Post Office. It also completed over 35½ kilom. of telegraph line between Luxembourg and Diekierch for the Luxembourg Telegraph Administration. Altogether this firm experienced brisk business. Johnson and Philips report that in their cable department the work was of a standard character. Important overhead line contracts were, however, carried out by the firm in many parts of the country, and the tendency to use medium-pressure overhead mains for village lighting was found to be greater than in the past. In the early part of 1921 the firm introduced a metal-sheathed wiring system, which has already acquired a good amount of popularity. Contractors in various parts of the country are said to have reported that, owing to the low cost of installing this system, they were able to accept contracts which would otherwise have had to remain in abeyance pending better times. The extension of the General Post Office underground trunk telephone cable system was steadily pressed forward by the Post Office engineering department. The London–Brighton duplicate cable, the Colchester–Ipswich, and the Birmingham–Wolverhampton sections were completed by Johnson and Phillips, and the cable for the Glasgow–Edinburgh line is at present in the course of manufacture in this firm's works, and will be ready to be laid this spring. The places at which the use of overhead power transmission lines has been sanctioned are referred to in the Electricity Commission section.

Electrically Driven Rolling Mills.

The use of electricity for driving rolling mills continues to increase, and during the period under review some large motors for this purpose were built. A 2500 horse-power machine and two 3000 horse-power motors were supplied by the Metropolitan-Vickers Electrical Company to the Appleby Iron and Coal Company, Limited. Two direct-current motors, one of 800 horse-power and one of 500 horse-power, were constructed by the same firm for driving a tire cogging mill, and a 750 horse-power motor for driving a tire finishing mill. Two motor generator sets were built for Cammell Laird and Co., two direct-current motors rated at 800 horse-power and 750 horse-power, and two rotary converters for Tubes, Limited, of Birmingham, and an equipment for a tire cogging mill for Beardmore, Limited.

Electric Ships.

As far as this country is concerned there is nothing to record in connection with the electric propulsion of ships, although there has, of course, been a considerable increase in the use of electricity for driving auxiliaries. The application of electricity for propulsion is confined at present mainly to America, where considerable headway is being made. During the past year much appeared in American technical journals and in papers read before various institutions concerning electric propulsion. In the November issue of the *Journal* of the American Society of Naval Engineers, for example, Engineer-in-Chief G. B. Newman stated that the coastguard cutters Tampa, Haida, Modoc, and Mojave, and four similar vessels now being built at the works of the Union Construction Company, Oakland, California, are being equipped with turbo-electric propelling machinery. In the February issue of the *General Electric Review* Mr. L. R. Emmet, who has probably devoted more attention to this problem than any other engineer, states that the applications of the system to naval vessels have given results in exact agreement with predictions, and a very large demand has been created for electric transmission equipments. The Eclipse, which is a cargo vessel having a dead weight of 11,868 tons is the first of twelve vessels of the United States Shipping Board to be fitted with electric propelling machinery, and a passenger ship Cuba, which has a displacement of 3580 tons, has been similarly treated. In view of the large amount of experimental work which the General Electric Company has undertaken in connection with cargo and passenger boats, a considerable demand for electrical plant is evidently contemplated, quite apart from the demand arising from the requirements of the American Navy. As regards the use of electricity for driving auxiliaries, Laurence, Scott and Co., Limited, who specialise in the manufacture of motors and switchgear for this class of work, report that during the year they supplied a large amount of electrical equipment for operating steering gear, capstans, windlasses and winches.

Electric Welding and Rivet Heating.

The demand for electric welding appliances appears to have been well maintained, and at the Engineering and Shipping Exhibition held at Olympia during October there was an excellent collection of arc and resistance outfits. The most important development of the year was the placing upon the market of the "Cyc Arc" automatic welding machine, as described in our issue of July 1st and in a paper read before the Institution of Electrical Engineers by Messrs. L. J. Steele and H. Martin. Since Elihu Thomson introduced resistance welding many years ago great developments have taken place in this direction, but the problem of welding electrically by direct means two pieces of metal of widely different sections has hitherto presented difficulty, and the welding of dissimilar metals of widely different melting points, such as brass and steel, had been considered to be impossible. The "Cyc Arc" process of automatic electric welding has, it is claimed, completely solved the problem, for with its aid masses of metal differing both in size and in quality can be automatically welded together without the use of any additional metal such as a metallic electrode. The electrical method of heating rivets by means of low-voltage alternating currents such as are used for resistance welding came very much to the fore during the past twelve months. At the Engineering and Shipping Exhibition held at Olympia during October several firms showed these machines. One advantage of the system, obviously, is that rivets can be heated at a moment's notice, for all the operator has to do is to switch on the transformer which provides the heating current. There are no fumes to pollute the atmosphere and the operators are not exposed to the intense heat of a fire. Furthermore, the machine can be brought close to the work.

Wireless Telegraphy and Telephony.

Telephonic communication between London and Amsterdam has been made possible by a wireless link connecting the trunk lines in the two countries. Small petrol generating sets supply the energy in the first instance and Marconi valve transmitters are utilised for the generation of the high-frequency oscillations. Another important application of the wireless telephone is between the Bar Lightship and the Mersey Docks and Harbour Board offices in Liverpool, a distance of about 12 miles. The installation at both ends consists of a standard 100-watt Marconi valve transmitter and receiver. Recently a special ringing up device was installed, so that it is unnecessary for anyone to remain on watch continuously. Telephonic communication is established between the lightship and the offices in precisely the same manner as with an ordinary telephone system, and it is said that the scheme works admirably. Most of the air liners plying between England and the

Continent are fitted with Marconi telephones, and a commercial telephone service is maintained with the base at the Croydon Aerodrome. In connection with marine work a device was introduced for ringing a bell automatically in the event of a distress call being received from sea. The problem was to devise a receiver which would respond solely to distress calls and not be operated by ordinary commercial signals. It naturally also had to work independently of atmospheric and local electrical discharges. The device which has been evolved responds perfectly to three dashes of four seconds duration, but will not work with any other combinations of signals, and it has been found to be invaluable in connection with ships which do not carry more than one or two operators and on which a continuous watch cannot be kept. Apart from the growing importance of the Transatlantic wireless services, a commercial service between London and Paris was commenced in January. A 3-kilowatt valve transmitter installed at Chelmsford, Essex, is operated from London over the land line and a similar transmitter is installed in Paris. With these arrangements high-speed communication is obtained both ways. During the recent assembly of the League of Nations a special wireless service was organised by Marconi's Wireless Telegraph Company to facilitate the transmission of Press dispatches from Geneva, a 6-kilowatt standard Marconi valve transmitter giving direct communication between London, Denmark, Sweden, and Spain. The transmitter installed at Berne was controlled automatically at high speed from Geneva. The prime mover was a 13-kilowatt Austin petrol-driven generating set. The signals were received in England at Witham in Essex on a direction-finding aerial 100ft. high and with a span of 200ft. Special circuits relayed the incoming signals on to the land lines running to Marconi House in London, where they were printed at high speed. For the purpose of acknowledging the signals and for sending service instructions back to Geneva a 6-kilowatt valve at Chelmsford was operated by a key at Marconi House. In view of the rapidly increasing number of wireless stations, there are many cases in which it is essential to have a receiver which will eliminate as far as possible not only atmospheric disturbances, but also all signals other than those it is desired to read, and in consequence of this the Marconi Company has perfected a new directional receiver, in the design of which advantage has been taken of several important developments, both as regards all-round reception and selective tuning. All-round reception can be utilised for rapid searching and where the ordinary methods of tuning are found to be satisfactory. Interference by signals arriving from directions approximately at right angles to that from which it is desired to receive signals is eliminated, as well as interference from directions approximately opposite to that of the station worked with. Probably the most important development from a commercial and political point of view was the installation of the modern valve transmitter at the Marconi Carnarvon station. With a bank of forty-eight valves it is possible to communicate with Australia. Apart altogether from the extreme simplicity of a transmitter composed of these valves, the arrangement is efficient and reliable, for in the event of one of the valves breaking it is merely necessary to replace it.

The Institution of Civil Engineers.

(1) "CONTROL OF TRAINS CONSIDERED IN RELATION TO INCREASES OF WEIGHT AND SPEED, COMBINED WITH REDUCED HEADWAY."*

By ALAN WOOD RENDELL, M. Inst. C.E.

IN his opening remarks the author draws attention to the stresses arising from the forces employed to accelerate and decelerate moving masses, such as railway trains, and observes that while the acceleration of such masses has always received much consideration, the deceleration does not seem to have been given the attention it deserves as an important factor in improving the traffic facilities on congested roads by reducing the headway between trains. The stresses arising from the forces employed to accelerate or decelerate a moving mass are briefly compared and reviewed, and attention is drawn to the average rates per second reached in acceleration, which are shown to be only about half the average rate per second which can be reached in deceleration. This difference will become more marked as the speed and weight of railway vehicles increases, provided the force developed in the brake system is increased in due proportion.

There are three main factors governing the rate of deceleration obtainable in a brake system, viz., (1) The brake shoe pressure and coefficient of friction; (2) the maximum brake cylinder pressure, and the time in which the maximum pressure is developed in the brake cylinder in every vehicle in the train from the moment of application; (3) the efficiency of the brake rigging in multiplying and transmitting this pressure to the wheels through the brake shoes.

Dealing with the first, the author explains that, although the coefficient of friction between the brake shoe and steel-tired wheels varies almost inversely as the speed, under the same conditions of pressure and speed the coefficient may range from a minimum of 7.8 per cent. to a maximum of 14.7 per cent., or from a minimum of 16.7 per cent. to a maximum of 26.9 per cent., according to the type of brake shoe employed. To obtain the best results, the actual bearing surface of the brake shoes against the tire of the wheel should be maintained at the maximum obtainable for the duration of each brake application, since the greater the pressure per square inch of bearing surface, the lower will be the mean coefficient of friction. In consequence, the use of two brake shoes per wheel is to be advocated, especially in view of the ever increasing axle-loads now carried.

Referring next to the question of brake-cylinder pressure and its rate of propagation throughout a train, the author lays stress on the importance of the first admission of an approximately equal degree of pressure to the brake cylinders on all the vehicles of the train being effected within the shortest possible time. This is necessary in order to prevent the vehicles at the rear of the train running on to those in front and pushing them forward, which not only retards the rate of deceleration, but also tends to breakages of couplings. The subsequent rises in pressure should also be distributed as evenly as possible throughout the whole length of the train. Diagrams of various applications are appended. Attention is also drawn to the desirability of keeping the size and weight of brake apparatus within reasonable limits, which, with the heavy units of modern trains, can best be accomplished by employing high brake-cylinder pressures, as otherwise either the size of the brake cylinders must be increased to inconvenient dimensions, or a number of brake cylinders must be installed on each vehicle, complicating amongst other things the arrangement of brake rigging. Attention is drawn to the delay in the development of pressure in the brake cylinders, and loss of power due to "false piston travel," or the movement of the piston in the brake cylinder before it does useful work.

This introduces the third important factor, viz., the efficiency of the brake rigging, and it is one which has perhaps been less regarded in the past than any other. The principal factors which conduce to increase the ineffective movement in the brake rigging are: the manner in which the brake shoes are hung in relation to the wheels; the wear of the pins and the spring of rigging due to weak design; and the movement of the frame of the vehicle on its springs. This travel is multiplied at the brake cylinder piston in proportion to the leverage adopted. It is important therefore that the leverage be kept within the lowest possible limits, and it is recommended that the continental practice of a ratio of 8:1 be not exceeded. It is also essential to good braking so to proportion the brake levers that the pressure developed in the brake cylinder shall be equally distributed to all the brake shoes of the vehicle, otherwise the effort of retardation will be concentrated on one pair of wheels, causing them eventually to skid, whilst the others are free to revolve.

Diagrams are given showing the variation of pressures on the rails between different wheels of a vehicle in "service" and "emergency" stops, and also of various methods of suspending the brake shoes, so as to obtain the greatest possible efficiency.

A useful formula for comparing stops in terms of the actual average deceleration obtained in percentage of the acceleration of gravity, or 32.2ft. per second, is given, and the article concludes with a few general remarks as to the importance to the most economic handling of rapid transport of a careful study of the problems of improved deceleration.

(2) "TRIALS IN CONNECTION WITH THE APPLICATION OF THE VACUUM BRAKE FOR LONG FREIGHT TRAINS."*

By Sir HENRY FOWLER, K.B.E., M. Inst. C.E., and HERBERT NIGEL GRESLEY, C.B.E., M. Inst. C.E.

It is now more than fifty years since the necessity of continuous automatic brakes for passenger trains was fully realised. To-day in this country there are two in use, the Westinghouse Brake and the Automatic Vacuum Brake.

In early days the type of vacuum brake employed was the "straight vacuum" brake. This was one of the earliest brakes capable of being applied by creating a vacuum by means of an ejector and released by destroying the vacuum. The pressure acting on the brake pistons or diaphragms could be varied and the maximum pressure obtainable was independent of the travel of the brake piston. As the ejector only worked when the brake was needed, this type was economical in steam consumption. It will be seen, however, that it was non-automatic, and any failure of the ejector or rupture of the train pipe rendered it impossible to apply the brake, and furthermore no indication of failure was given to the driver until he found the brake useless. It was therefore imperative that a brake should be so constructed that any failure should result in automatically applying the brake. This made it necessary to maintain a vacuum in order to keep the brake off.

The train apparatus is simple, each vehicle having a train pipe coupled up with cylinders in which the movement of pistons or diaphragms operates the brake. This arrangement proved satisfactory in dealing with the trains of the length met with in this country to within the last few years. Due, however, to steadily increasing length and weight of passenger trains, developments consisting of accelerators and more powerful ejectors have been introduced. A fresh aspect of the brake problem is presented by the growing tendency to use the continuous brake for certain classes of goods traffic.

The main difference between braking goods trains and passenger trains are briefly as follows: (*a*) The greater length of goods trains; (*b*) the necessity of running loaded and empty wagons together in goods trains; (*c*) even if screw couplings are used, the need of quickly coupling and uncoupling when shunting will probably result in the couplings being screwed up less tightly than in passenger trains. This tendency to couple loosely enhances the need for a smooth and uniform action of the brake throughout the train.

With a view to ascertain the suitability of the vacuum brake for long goods trains, a series of trials were carried out during the summer of 1919 by the authors on the Great Northern Railway between Peterborough and Firsby. The following conditions were laid down as a standard of satisfactory performance:—That trains of 100 wagons, close coupled, must be stopped: (1) By emergency applications without shock and without any risk of parting the train; (2) by service applications without shock or risk of parting, and in such a manner that the train could be restarted immediately after coming to rest; (3) that the speed of the train could be reduced as required.

The train consisted of Great Northern Railway 8-ton covered vans fitted with the Great Northern Railway standard vacuum brake, with the Westinghouse Brake Company's accelerators and reducing nipples. In addition to these the train included three Midland Railway 6-wheeled vans carrying the necessary recording instruments. One of these was placed at the front of the train, one in the middle, and one at the rear. All the vans were unloaded and provided with screw couplings. The brakes were tested for leakage before the trials, and the travel of the brake pistons adjusted as required. The instruments comprised speed recorders and duplex vacuum recorders. The latter instruments (one of which was placed in the front, middle and rear vans) recorded the pressure in the train pipe and brake cylinder reservoir.

The average retarding force is the basis usually adopted for comparing brake stops. This force is convenient to express as a percentage of the weight of the train, and in the calculations, the weight of the train is taken as the gross weight of the train increased by the equivalent rotary inertia percentage, which was found from calculation to vary from 10.4 to 10.7 per cent. of the weight of the train. The forces concerned, inclusive of brake power, friction and gravity, are assumed to be acting uniformly throughout the stop.

The stopping efficiency for the different trains has been found by expressing the actual average retarding force as a percentage of the average retarding force corresponding with the speed-distance curve which was plotted from the results obtained from a train of 63 vans which was adopted as a standard for comparison.

Effects observed on the stopping of various trains under different conditions.—63-van train, fitted with accelerators and standard reducing nipples.—All emergency stops made under these conditions were satisfactory. It was found necessary in making speed reductions or service stops, to apply the brake gradually, otherwise the accelerators operated, and unless the speed was high, say over 30 miles per hour, the train came to a stand before the brakes could be released.

The 80-van train was made up by attaching nine vans at the front of the previous 63-van train and eight vans at the rear; these vans had not accelerators or reducing nipples. The records of these stops were spoilt on account of the effect of the shocks on the instruments, and it was decided to abandon further trials with trains not completely fitted with accelerators.

The 82-van train, fitted with accelerators and standard reducing nipples throughout.—At speeds above 40 miles per hour the stops were fairly smooth, but between 30 and 40 miles per hour there was a rough jerk just before stopping, and for stops from 20 to 30 miles per hour the jerk was very severe just before coming to rest. The stopping distances of this train were almost identical with that of the 63-van train. Emergency stops were tried with the working vacuum reduced to 16in. These were fairly smooth except at the lower speeds, but the stopping distance was increased by about 20 per cent.

82-van Train specially fitted with accelerators and specially reduced nipples.—The effect of the reduced nipples was to make the stops at all speeds quite satisfactory as regards being smooth, but increased the stopping distance by about 25 per cent.; 101-van train, fitted with accelerators and specially reduced nipples.—The emergency stops were quite satisfactory as regards being smooth, but compared with the standard of comparison—63-van train—the stopping distance was increased by about 35 per cent. Emergency stops were also made working with a 16in. vacuum. In this case the stops were very smooth, but the stopping distance compared with the standard was increased approximately by 50 per cent.

Tables are given showing particulars of the various trains experimented with, and the speeds, stopping distances, and efficiency of the stops, etc., the relation between the speed and the stopping distance for different trains is also shown graphically. Curves are given showing the rise in effective pressure on the brake pistons at any instant after the application of the brake, and particulars of observations made to ascertain the time taken to release the brakes on the various lengths of trains tested.

* Official abstracts of two papers read at the ordinary meeting of the Institution, on Tuesday, January 10th, 1922.

COMBATING AN EFFECT OF THE DROUGHT.

THOUGH we in this country have suffered from the effects of the drought, we have not felt those effects in quite the same way as have those countries which rely largely on water power. In Switzerland and Italy, for instance, water power largely replaces coal and oil, and some of the manufacturers in those countries have been hard hit. As an example we may quote the case of the Fiat Company, the Turin works of which are ordinarily run practically entirely by electricity generated by water power from the Alps. The company has its own power station, and in normal times the excess power not used at the works provides lighting for the city of Turin. The drought having seriously diminished the flow of water to the power station, the factory was recently faced with an entire absence of power. The situation looked menacing, but it was met by driving the machinery in the works by means of a number of the firm's agricultural tractors—no less than 150 being run in constant service. Connected by belts to the line shafting, these tractors completely took the place of the usual electric plant, and we understand that they proved so satisfactory in use that the output from the factory was in no way curtailed by the drought. The tractors worked most successfully and showed no inclination to over-heat as the result of their being stationary within the heated atmosphere of the workshop.

THE Blackwell Colliery Company, Limited, has, according to the *Iron and Coal Trades Review*, notified its workmen that unless they fill better coal the owners will enforce the filling of coal by hand-picking and screens.

A Seven-Day Journal.

Railway Wages Decision.

THE inquiry by the National Wages Board into the application of the Scottish railway companies' application on the subject of wages has resulted in a compromise. The principle of the eight-hour day for railwaymen is to be retained, a decision which has, of course, given great satisfaction in railway trade union circles; but it has been demonstrated during the inquiry that the universal application of the eight-hour day is associated with anomalies. It has therefore been decided that the hours of work shall be governed to some extent at least by local conditions, and it has been agreed that at some of the smaller country stations in Scotland the eight-hour day shall be spread over a longer period up to twelve hours, as the work is extremely light in comparison with that which has to be performed at large town stations. The application for a reduction of wages has only met with partial success. The railway companies' request was that the advance given in June, 1920, which averaged from 4s. 6d. to 5s. per week, should be deducted in one instalment; but the Wages Board has decided that the reduction shall only be effected by stages. The night duty payment will be continued, but the age of those ranking for adult pay has been raised from eighteen to twenty years.

New Dry Docks.

IT has been decided to construct a new graving dock at Swansea to meet the requirements of the oil tankers which are now coming to the port to make deliveries of crude oil to the new refineries at Llandarcy and to receive refined oil cargoes. The dock, which is to be built by Palmer's Shipbuilding and Iron Company, is designed to be over 700ft. long, and a site has been selected for a second dry dock of only slightly smaller dimensions. A scheme is also under consideration for a new graving dock at Burntisland. The want of ship repairing facilities on the north shore of the Firth of Forth has, it is believed, retarded maritime developments to a considerable extent, and the North British Railway Company, which has interests at Burntisland, is said to be a supporter of the scheme. A site has been selected in consultation with the Harbour Commissioners.

Imperial Airship Services.

MUCH disappointment has been caused by the announcement that neither the New Zealand nor the South African Governments will participate in the scheme for Imperial airship services. The reason assigned for abstention is the financial situation. Nothing is yet known as to the attitude which will be adopted by the Government of India, but in well-informed quarters there is a tendency to believe that the airship scheme is regarded with favour, and that the necessary financial guarantees are likely to be forthcoming. The Australian Government is favourable to the scheme, and should India decide to participate, it would be possible to inaugurate an England–Egypt, India, and Australian service, leaving the extensions to South Africa from Egypt and to New Zealand from Australia to be made at a later date. The possibility of making a start with Empire services depends, however, upon the willingness and ability of the Government of India to find the money required.

Railway and Dock Rates on Coal.

A STRONG protest has been issued by the Mining Association on the subject of the continued high charges of railway and dock companies on coal traffic. The Association asks for the total abolition of the flat rate, as the retention of a flat rate addition of 4d. per ton leaves the conveyance rates on the great bulk of export coal of some districts at about 110 per cent. above the pre-war level. The retention of the flat rate addition also seriously affects a large volume of inland short-distance traffic, for example, the iron and steel industry in the Cleveland and other districts, and coal traffic from pit to washeries, in the same way as in the case of shipment traffic, and the abolition of the flat rates is urgently necessary as a step which will greatly assist in the revival of the above-mentioned industries. A request is made for the appointment of a Joint Committee to discuss the whole situation with regard to industrial, domestic, and coal intended for shipment abroad.

German Shipbuilding.

INTEREST in the annual summary of the world's shipbuilding, which has been issued this week by Lloyd's Register of Shipping, will mainly concentrate on the figures giving the output from German yards, as most of the other outputs are already known by information from other sources. Germany has risen to the third rank in this shipbuilding table, her yards having put into the water last year over 509,000 tons, compared with 1,528,000 for Great Britain and Ireland and 1,000,000 tons for the United States. Holland occupies the fourth place and Japan the fifth. The falling off in the output from Japanese yards is somewhat surprising. It is, however, on the German industry that all eyes will be turned, and, having regard to the fact that a very small amount of tonnage is now under construction in United States yards, it seems clear that Germany must occupy the second place when the story of the current year's shipbuilding comes to be written. Deprived of her mercantile marine by the terms of the Peace Treaty, it is evident that Germany is making a determined effort to gain her old position in the shipbuilding and shipping industries. Owing to the low rates of wages prevailing in Germany and the complication caused by exchange conditions, the situation will need to be closely watched.

Cast Iron Imports.

REPRESENTATIONS were made at this week's inquiry by Sir William Acworth's Committee, in connection with the Safeguarding of Industries Act, as to the strength of German competition in light castings. The chairman of the Light Castings Association, Mr. John King, gave evidence as to cost of production in Great Britain and in Germany, the figures submitted bearing particularly on rates of wages. In the Cologne district it was stated that moulders and fitters were being paid 13 marks per hour and foundry labourers 10.75 marks per hour. In addition, an allowance was made to married men for their wives and children. In Saxony the rates of wages were said to be lower. This means, when allowance is made for exchange rates, that British rates of wages are four times greater than those paid in the Cologne district. The request made by the Association is that under the present abnormal conditions steps should be taken under the Act to check German imports, owing to the effect on employment in the home industry.

Australian Railway Gauge.

THE report that an offer has been made by strong British interests to convert the Australian railway system to standard gauge is now confirmed. It will be recalled that this vexed question was the subject of a recent investigation by a joint commission, of which English, American and Canadian railway experts were members, and that the report made recommended the adoption of a uniform gauge of 4ft. 8½in. This proposal was accepted by a conference of the State authorities in November last, and the definite offer to carry out the conversion was considered by a conference which met last week. The selected standard gauge is that of the New South Wales Railways, as well as of the East-West transcontinental line—the gauge of the Queensland and Western Australian lines being 3ft. 6in., and that of the railways of Victoria and South Australia 5ft. 3in. The syndicate which has offered to do the work would, it is understood, be willing to accept payment in fifteen-year 6 per cent. bonds. The latest news is that further consideration of the scheme has been postponed.

Important Contracts for British Firms.

COMPETITION in the electrical engineering industry is so keen and the British branch of it is under existing conditions so heavily handicapped owing to the influence of exchange and labour conditions, that the news of the placing of the big South African contract with the Metropolitan-Vickers Company has given general satisfaction. It is understood that the contract, which will involve the supply of electric locomotives for service on the South African railways and other material, represents a capital outlay of of from £750,000 to £1,000,000. It is the first order which has been placed in connection with the conversion from steam to electric traction of the Glencoe-Pietermaritzburg line, and was obtained in the face of keen competition from European and American firms.

A Record of Scientific Apparatus.

THE attempt which is being made to found what may be termed a journal dealing with scientific instruments will, it is hoped, succeed. It will be possible, when the preliminary number now in preparation is available, to pass a more definite opinion. The sponsors of the new publication are the National Physical Laboratory, the Institute of Physics, and the Department of Scientific and Industrial Research, and the expenses of issue are apparently being borne by the Government Department named. Most scientific men will admit the need of the journal, which aims at placing at their disposal a full and correct record of the instruments which are being constantly invented for the purposes of research workers, and remain so unknown to other investigators that quite frequently the same instrument may be designed several times over. The record it is now proposed to make will serve an even wider use, as it will enable scientists of all nationalities who have access to it to keep themselves in touch with the progress being made in technical methods in all countries. That the list which is to be compiled and the accompanying drawings and description may not be quite complete must be anticipated; but, even making allowances for things which may be missed either by reason of the secrecy observed by inventors or other causes, the task which is now in progress is worth doing. Sir Richard Glazebrook, when he guided the N.P.L., had the scheme in mind, and his successor, with those now associated with him, has carried it to the point of accomplishment.

Underground London.

IN the progress of the work of laying underground telephone cables in the London area some interesting discoveries have been made by the engineering staff of the Post Office. The most interesting section of the work from this standpoint was the duct work between St. Paul's Churchyard and Fleet-street, many obstructions being met with, which made it necessary to carry the trench in which the duct is laid to an abnormal depth. In an account of the work given in the Post Office Electrical Engineers' *Journal* it is stated that the old Fleet River, now enclosed in a culvert, was encountered at Ludgate-circus at a point 3ft. from the surface. As the culvert is 24ft. deep it was decided to carry the Post Office cables at this point in steel pipes. Provision had to be made in selecting the line for the pipes across Ludgate-circus for other conduits and obstructions, and, having regard also to the necessity of minimum interference with the heavy traffic at the Circus, trenching operations presented more than ordinary difficulties. In consequence of the duct route following a line of sewer which discharges into the Fleet sewer at Ludgate-circus, a specially designed manhole with splayed corners had to be constructed, this being the first of the kind in the City of London.

Air Research and the Government.

USEFUL service to the cause of aviation was rendered by the deputation from the Council of the Royal Aeronautical Society which waited on the Secretary of State for Air to urge the importance of applied scientific research work. The deputation, which included Colonel O'Gorman, Professor L. Bairstow, and Sir Mackenzie Chambers, drew attention to the neglect of that side of research work which was regarded as of fundamental importance, and asked for the appointment of a man of high scientific qualifications, to whom would be assigned the duty of safeguarding research, keeping it in touch with the scientific work of the country, and with the problems of both civil and military aviation. It was also suggested that a sum of money should be allocated to research as defined by the deputation, and that an Advisory Committee, composed of scientific men and external to the Air Ministry, set up. The Secretary of State has not committed himself to the acceptance of these proposals, and it would be optimistic to place too much hope on the promise made that they would receive sympathetic consideration. That is the stock reply of the politician when deputations assail him.

Diesel Engines for Aircraft.

REPORTS are in currency to the effect that research work which has been in progress at the Royal Aircraft Establishment at Farnborough is likely to lead to the development at an early date of a practical engine for aeroplanes which would be operated on the Diesel principle. It is said that in Germany a six-cylinder engine of this type for aircraft has been designed and built, and that French engineers are on the eve of achieving a similar success. From the point of view of aircraft operation the elimination of the magneto and carburetter and the possibility of using heavy oil with a high flash point is much more important than in other applications of engines designed on what, to the injustice of British workers, is commonly known as the Diesel principle. The reduction of the fire risk and the ability to use cheaper fuels than those now employed are most important considerations.

A New French Gun.

EXPERIMENTS with the new gun device, the invention of a French artillery officer, the feature of which is the high initial velocity of projectile which can be attained, are to be carried out at Liége. It is reported that in preliminary trials an initial velocity was attained with the famous French "75" of 850 m., whereas the normal figure is only 530 m. It is anticipated that in the Liége trials a velocity of 1000 m. may be reached. Eminent artillerists are expected to be present at Liége next week, which has been provisionally fixed for the tests by the Belgian Government.

Institution of Mechanical Engineers.

ALTERATIONS OF ARTICLES OF ASSOCIATION.

AN extraordinary general meeting of the Institution of Mechanical Engineers was held on Friday, January 20th, at Storey's Gate, for the purpose of considering various alterations to the articles of association of the Institution. The president, Captain Riall Sankey, was in the chair.

In bringing forward the proposals the President said that they had occupied the attention of the Council for a period of about eighteen months, and were the result of its unanimous decisions. The first subject dealt with at the meeting was the status of associate members, who, the President pointed out, were not members of the Institution according to the present articles of association. It was thus proposed that both the members and associate members should be classed as corporate members and have voting powers. In view of the fact that the term "graduate" did not seem to apply properly to the members now bearing that title, it was proposed to raise the status of the graduates to a position intermediate between the students and associate members, and to create a new class of students, who would be eligible at the age of sixteen years. With the object of encouraging people to join the Institution who were not necessarily engineers but desired to promote the science of mechanical engineering, it was also suggested that two new classes should be formed—Companions, who would be at least forty years of age, and Associates, who would be at least twenty-five years old.

There was some discussion by several members as to whether it was right that these proposals should be adopted by the meeting, on the score that the meeting was not necessarily representative of the whole membership of the Institution, and it was suggested, as an amendment, that the proposed alterations should be submitted to the vote of the whole of the members by post. Captain Sankey pointed out that such a procedure would delay matters for a year, and Dr. Hele-Shaw explained how the Council had come to make its proposals only after long experience of the applications for membership. It was also pointed out that all the home members had had the proposals before them for a fortnight. The amendment was lost, on being put to the vote, and the resolutions were agreed to.

The President then said that the Council had adopted a suggestion, put forward by Mr. Moss, that there *should* be three associate members on the Council, instead of leaving the constitution of the Council such that it *might* include three associate members. Several members, however, urged that three associate members were not enough, and after a considerable amount of discussion, in which Dr. Hele-Shaw pointed out that there were not many associate members who could afford the time to attend the meetings of the Council, while Mr. Patchell suggested that there might be a point of the Council losing its character as representative of the whole engineering industry, it was finally agreed that the Council should include not less than three or more than seven associate members. Several other minor matters were then discussed by the meeting and were agreed to. That completed the business of the extraordinary meeting.

In opening a general meeting, immediately afterwards, the President announced the death of Mr. Edward Hopkinson, and that Senatore Marconi had been elected an honorary life member of the Institution. The Secretary read out the proposed list of new officers of the Institution for next session, and some amendments to the by-laws were put in by members for discussion at the second extraordinary general meeting, which is to be held on February 17th.

As it was getting late by this time it was decided not to ask Messrs. H. S. Denny and N. V. S. Knibbs to present their paper on "Some Observations on a Producer-Gas Power Plant," which was in the programme for the evening, but to adjourn till February 3rd, to discuss the paper. A summary of the paper is given below.

SOME OBSERVATIONS ON A PRODUCER-GAS POWER PLANT.

THE paper bearing the above title, which was to have been read last Friday night, was presented for discussion at Manchester yesterday (Thursday). It was a lengthy one, and, moreover, was of a highly statistical nature. It does not, therefore, readily lend itself either to being abstracted or summarised, and should certainly be consulted in the original by those particularly interested in its subject. For the sake of the general reader, it may be said that it related to the performance of a large Mond gas-producer gas-engine electrical plant which, in 1917-19, was under the authors' control, and which they subjected to a thorough and lengthy investigation as to performance and efficiency. Details of the plant are as follows:—

Producer Portion.—Erected, 1909. Consisted of seven 10ft. 6in. Mond producers designed to gasify 24 tons of coal per day each.

Gas Engine Portion.—Consisted of nine "National" gas engines, five of 1500 horse-power, two of 1000 horse-power, and two of 750 horse-power.

Electrical Portion.—Consisted of nine B.T.H. dynamos, five of 1000 kilowatts, two of 700 kilowatts, and two of 500 kilowatts.

Steam-raising Plant.—Consisted of seven Lancashire boilers, of which four were used to supply the gas generators, the others being employed to supply the steam-driven pumps and blowers. In addition, the exhaust from each gas engine was led through an exhaust boiler, the whole of the steam thus produced being used in the gas generators.

Cleaning, Cooling and Recovery Plant.—The gas leaving the producer passed through a "superheater," or heat exchanger, and thence to a washer wherein it was cooled and freed from soot, &c. From the washer it was led to a sulphate recovery tower, in which it was scrubbed by liquor containing weak sulphuric acid and thence to a gas tower in which it was cooled by water and freed from most of its tar. A second tower was installed to cool the gas still farther. Thereafter it was led to the engines.

Air-supply Plant.—A Roots blower delivered air to an air tower down which was flowing the hot water from the gas-cooling towers just mentioned. The air was farther heated and saturated by means of steam, whereafter it was led through the "superheater," or heat exchanger, referred to above. Thence it was passed round and into the producers.

The test results are summarised, so far as they can be, in the following statement.

Coal Used.—Pit slack of the following average percentage composition:—Fixed carbon, 53; volatile combustibles, 34; ash, 9; moisture, 3.5; nitrogen, 1.4; sulphur, 0.85. Average calorific value, 12,500 B.Th.U.

Quality of Gas Produced.—Over a long period the gas produced had the following average percentage composition:—CO, 9; H_2, 23.2; CH_4, 3.3; CO_2, 15.7; N_2, 48.8. Net calorific value, saturated at 15 deg., 121 B.Th.U. These figures in nearly every case are stated to be less favourable than others previously reported for Mond plants.

Tonnage Gasified.—During a portion of the test period the plant was not called upon to gasify more than 16 tons of coal per day per producer. Later, when maximum production was required, it could not be pushed beyond 19 tons, although its designed capacity was 24 tons per producer. It is added, however, that with better quality coal the tonnage gasified could doubtlessly have been increased.

By-product Recovery.—Over a period of eight months the by-products recovered per ton of coal gasified averaged:—Ammonium sulphate, 60.4 lb.; pitch, 35.4 lb.; washer dust, 100 lb.; washer liquor (as ammonia), 0.76 lb. The sulphate figure compares with 147 lb. theoretically equivalent to the nitrogen in the coal and 80 lb. and over claimed to be ordinarily recoverable. It is added, however, that for a period before the gas engines were installed the producer gas was used merely for boiler firing, and that the producers were run with a view to the maximum production of sulphate irrespective of the quality or quantity of the gas. During this period the sulphate recovery averaged 76 lb. per ton of coal.

Mechanical Arrangements and Boilers.—The arrangements for removing tar and dust from the gas mains were, according to the authors, inadequate. On one occasion the choking of the gas mains resulted in the whole gas plant having to be shut down for three weeks. The liquor tanks were badly laid out, and led to a considerable loss of ammonia. The boiler plant was poor. Two tests showed thermal efficiencies of 51 and 43 per cent.

Gas-cleaning Plant.—The performance of the gas-cleaning plant was satisfactory, the average combined dust and tar content of the gas being 0.05 gramme per cubic metre.

Gas Engines.—The engines behaved well on full load, but on overload considerable pre-ignition developed during the first trials, and none of the nine engines would meet the 10 per cent. overload requirement until the type of inlet valve had been changed. In general, however, it may be said that the engines very satisfactorily performed their duty.

Exhaust Boilers.—The exhaust boilers gave much trouble by reason of contamination in the feed water and consequent corrosion in the tubes.

Electric Generators.—The only trouble experienced with the dynamos was caused by dust, and was soon overcome.

Thermal Efficiency and Heat Balance of Producers and Power Plant.—In investigating the efficiency of the producers and power plant the first problem was to determine the amount of gas received from the producers. Ultimately, as an average of the results indicated by four different methods, it was decided to base all calculations on a yield per ton of coal gasified of 130,000 cubic feet of gas saturated at 15 deg. Cent., and under standard pressure. On this basis a week's test gave the following figures in Centigrade heat units as the heat balance of the producers:—

Heat entering Producer System.

	C.H.U.
As coal gasified	14,250,000,000
As coal burnt under boilers	3,780,000,000
As steam from exhaust boilers	1,420,000,000
Total	19,450,000,000

Heat leaving Producer System.

Gas—	
Net calorific value	8,295,000,000
Gross calorific value	9,300,000,000
Available heat, sensible and latent, in gas	4,970,000,000

From these figures the authors compile various efficiencies ranging from 80.9 to 42.7 per cent. The latter is based on the net cold gas value and the gross heat used on the producer plant, and is stated to be the one which really shows the effective efficiency of the plant. The electrical units generated during the week amounted to 975,000 kilowatts, equivalent to 1,849,000,000 Centigrade heat units. The overall thermal efficiency of the entire plant based on gross coal used and electrical horse-power produced was, therefore, 10.2 per cent. The generator efficiency was 93 per cent., and the gas-engine efficiency 24 per cent., "a very fair figure considering the conditions." The producer efficiency is stated to be "very low compared with text-book and catalogue figures." The low overall efficiency is only partly accounted for by the "exceptionally low" efficiency of the boilers. The air-heating tower is regarded as effective, but the "superheater" is characterised as bringing about only a comparatively small exchange of heat.

Capital and Operating Costs.—In the concluding portion of the paper the authors dealt with the capital and operating cost of the plant. The actual capital cost of the producer portion was not known, but it is estimated at £45,000. The cost of the gas-cleaning plant, gas engines, auxiliaries, exhaust boilers, dynamos, switchgear and buildings is returned at £182,000. The total capital cost at full load—7500 e.h.p.—was, therefore, £30 4s. per electrical horse-power. No attempt is made in the paper to adjust these figures to the values ruling to-day. As regards operating costs, the period June to October, 1918, during which the plant was running under approximately full load conditions is taken as the basis with the cost of wages, fuel, &c., at the levels then prevailing. With coal at 12s. 6d. per ton, the cost of gas production is worked out at £1.154 per ton of coal gasified, the three items affecting this figure being gross cost, £1.274; deduction for by-products, £0.455; addition for general expenses and oncost, £0.335. With this figure as the cost of the gas, the cost of the electrical power generated is given as 0.388d. per unit. In none of these figures is any allowance made for depreciation, insurance, or interest.

The authors' general conclusions are summarised as follows:—

(1) *Mond Gas.*—(*a*) That a reasonably high ammonium sulphate recovery demands low temperature and correspondingly low producer gasification capacity, whilst simultaneously the gas produced is less suitable for power purposes than that made in non-recovery producers. (*b*) That at full load a gas suitable for the engines was obtained only at the sacrifice of ammonium sulphate recovery. (*c*) That a large amount of steam is used, demanding a considerable boiler installation and fuel usage. (*d*) That the capital outlay and running cost of the plant represent a combined charge which can only be counterbalanced by a comparatively low-priced fuel, and a high market price for the by-product.

(2) *The Gas Engine.*—(*a*) That steady running and reliability are obtainable given the necessary skilled attention, and given a gas of even character and value. (*b*) That the time lost for repairs is almost negligible. (*c*) That oil consumption can be kept at a low level, and one that compares not unfavourably with steam practice. (*d*) That relatively low hydrogen and high carbon monoxide proportions make for steadier and cheaper running than when the order of these constituents is reversed. (*e*) That efficiency falls very rapidly as load decreases. (*f*) That a thermal efficiency of 26 per cent. at full output, and with a steady suitable gas supply, is obtainable. (*g*) That natural gas, blast-furnace gas, and coke-oven gas represent a wide and favourable field for the gas engine. (*h*) That the gas engine plant as a whole gives little trouble and satisfactorily stood up to its tests on full load and part load, and also under ordinary working conditions.

Single and Three-Phase Alternating-Current Commutator Motors with Series and Shunt Characteristics.*

Commutator Motors.—In principle the commutator motor—the action of which is independent of the speed—is eminently adapted for economical speed control and large starting torque, while in many cases a phase advancement can be obtained in addition. Considering, for simplicity, the direct-current motor, where the use of a steady flux results in a continuous pressure between the commutator brushes, the speed is proportional to—

$$\frac{\text{supply voltage} - \text{pressure drop}}{\text{flux}}$$

The torque depends on the product of the armature current and flux. Ignoring speed regulation by series resistance as uneconomical, it follows that the speed can be controlled by varying either the voltage or the field. With a single machine, voltage control is impracticable with direct current, but practicable with alternating current, because a variable-ratio transformer or other device can be used.

With field control, the only economical method possible with a single direct-current motor, the torque varies inversely as the speed, assuming constant armature current; so that the output remains constant over the

* Based on a lecture delivered before the Institution of Electrical Engineers by Dr. Stanley Parker Smith.

whole speed range. Consequently, a variable-speed direct-current motor must be designed for the full output at the lowest speed, while at all higher speeds the material cannot be efficiently utilised. With voltage control, which is possible with alternating-current motors, both field and armature current can be kept constant over the whole speed range. Therefore, a constant torque is maintained, and the output is consequently proportional to the speed. This not only enables the material to be fully utilised over the whole working range, but corresponds more closely to the load characteristics of the majority of drives. For example, for a speed range of 1 : 3, a motor with field control would only give, say, 10 horse-power over the whole range, whereas a motor with voltage control would give 10 horse-power at the lowest speed and 30 horse-power at the highest speed.

Alternating-current Commutator Motors.—From a practical point of view, the alternating-current commutator motors unite most of the drawbacks of the direct-current motor with those of the induction motor. In addition, a worse evil, the transformer E.M.F. induced in the coils being short-circuited by the brushes becomes one of the predominant factors in the design. From all these considerations, the air gap has to be kept short, the armature reaction has to be compensated, and a low commutator voltage has to be employed, sometimes at the cost of a transformer. The success attained in the development of commercial machines of numerous types represents one of the most signal achievements in the design of electrical machines.

As a matter of historical interest in connection with the original inventors of these machines, it may be said that the first mention of the fact that the series motor, when laminated, could work with alternating current, appears to have been made by Alexander Siemens in 1884, in a discussion at a meeting of the Society of Telegraph Engineers; while the polyphase commutator motor was patented by Ernest Wilson in 1888—F.P. 18,525. About the same time, Wightman in America discovered rotor excitation, and, in 1898, Ll. B. Atkinson, in his paper on "The Theory, Design and Working of Alternating-current Motors," before the Institution of Civil Engineers, showed how the single-phase commutator motor could be made to yield a shunt characteristic. The invention of the induction motor by Ferraris and by Tesla in 1885-86, and its much more rapid development, afford an insight into the difficulties associated with the development of alternating-current commutator motors.

Single-phase Commutator Motors, with Series Characteristics.—Some of the chief types are illustrated in Fig. 1. The more rapid development of these types is attributable to two causes—their relative simplicity and the incentive afforded by the prospects of railway electrification.

(A) The compensated series motor has ousted all other types as a single-phase traction motor. For this work it is usual to neutralise the transformer E.M.F. in the short-circuited coil, by means of a rotational E.M.F. induced by the flux produced by an interpole winding shunted by a resistance and excited by the main current. This gives the motor a very wide speed range. The speed is controlled from rest by means of a variable ratio transformer, a transformer being also necessary for reducing the supply voltage to the motor voltage. High power factor is obtained by designing the motor with a weak field and a strong armature magneto-motive force, by working well above synchronous speed, and by reducing inductive effects. On Continental single-phase railways, inductive effects are reduced by adopting a frequency of 16⅔ periods per second. The compensating winding may be joined in series with the armature winding or it may be short-circuited on itself. These motors have been built for outputs up to 3000 horse-power while motors for 500 horse-power are quite common. About 40 to 50 horse-power per pole may be considered to be good design for large motors.

(B) In the series repulsion or doubly fed types, power is supplied to both stator and rotor. Feeding via the stator is effected by the creation of a transformer flux—compare the action of the induction motor—along the brush axis. By reducing the ratio of the stator pressure to the rotor pressure as the speed rises, an approximate neutralisation of the transformer E.M.F. in the short-circuited coils can be obtained. However, this type has practically given place to type (A).

(C) In the plain repulsion motor the whole of the power is transferred inductively to the rotor, while the rotor voltage can be fixed independently of the stator voltage, so that no transformer is needed. At synchronous speed the transformer flux is correct for neutralising the inductive effects of the exciting flux on the short-circuited coils, so that the commutation conditions become similar to those in a direct-current machine. At other speeds, however, the magnitude of this flux is not correct for this purpose. This effect is particularly bad at hyper-synchronous speeds, and the net result is that all motors of the repulsion type are ill-suited for wide speed ranges. The repulsion motor has a series characteristic because the exciting flux is produced by the main current.

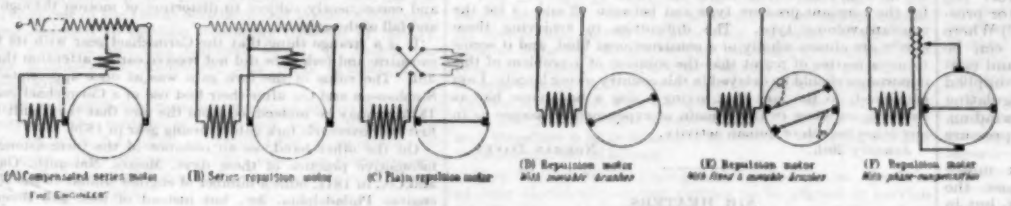

(A) Compensated series motor
(B) Series repulsion motor
(C) Plain repulsion motor
(D) Repulsion motor With movable brushes
(E) Repulsion motor With fixed & movable brushes
(F) Repulsion motor With phase-magnetiser
Speed curves for D.F compensated series Traction motor
Speed - Miles per hr.
Amperes
Single-phase motors with series characteristics

FIG. 1—SINGLE PHASE COMMUTATOR MOTORS WITH SERIES CHARACTERISTICS, AND SPEED CURVES

(F) Phase compensation is obtained by rotor excitation. These motors were used on the original electric rolling stock of the Brighton Railway, being practically the only type available at that time. The motor suffers, however, from the necessity of working in the neighbourhood of synchronous speed, while the superiority of type (A) has ousted it, along with other competitors from traction work.

Motors with Shunt Characteristics.—These are shown in Fig. 2. The shunt motor needs two sets of brushes, the main and the exciting brushes. The activities of inventors have been even greater in connection with shunt types than with series types.

(A) The plain shunt motor is decidedly inferior to the single-phase induction motor, for, in addition to possessing no starting torque, both efficiency and power factor are lower, and the motor runs merely at one speed, i.e., synchronism. Some methods of overcoming these drawbacks are illustrated in Fig. 2. (B) Phase correction is obtained by injecting a fraction of the applied pressure into the exciting circuit. (C) A large starting torque is obtained by letting the motor run up to speed as a repulsion motor. The machine can then be made to run as a single-phase induction motor, but it is becoming common to combine the devices in (B) and (C) in order to obtain a constant-speed single-phase motor with high power factor and large starting torque. (D) Speed regulation of the shunt motor is obtained by varying the exciting flux—an inductance being used to raise the speed, and a capacity to lower it—or an auxiliary winding can be employed for this purpose. (E) In the doubly fed type, the speed is varied by regulating the pressure applied to the brushes in the transformer axis. This motor, the series-repulsion motor and the three-phase commutator types belong to the general class of electrical machines in which energy is supplied to both stator and rotor, the power relations being definitely associated with synchronous speed.

Three-phase Commutator Motors.—The addition of the commutator to the rotor of the three-phase induction motor raises the frequency of the slip energy to the frequency of supply, and thereby enables this energy to be taken from, or returned to, the supply network, according to whether the speed is above or below synchronism. Thus, the motor range is not confined to sub-synchronous speeds, as in the induction motor. The limitation imposed on the speed-range of the three-phase commutator motor by the transformer E.M.F. induced in the short-circuited coils is similar in effect to that imposed on the repulsion motor, while the rotor is wound for equally low voltages.

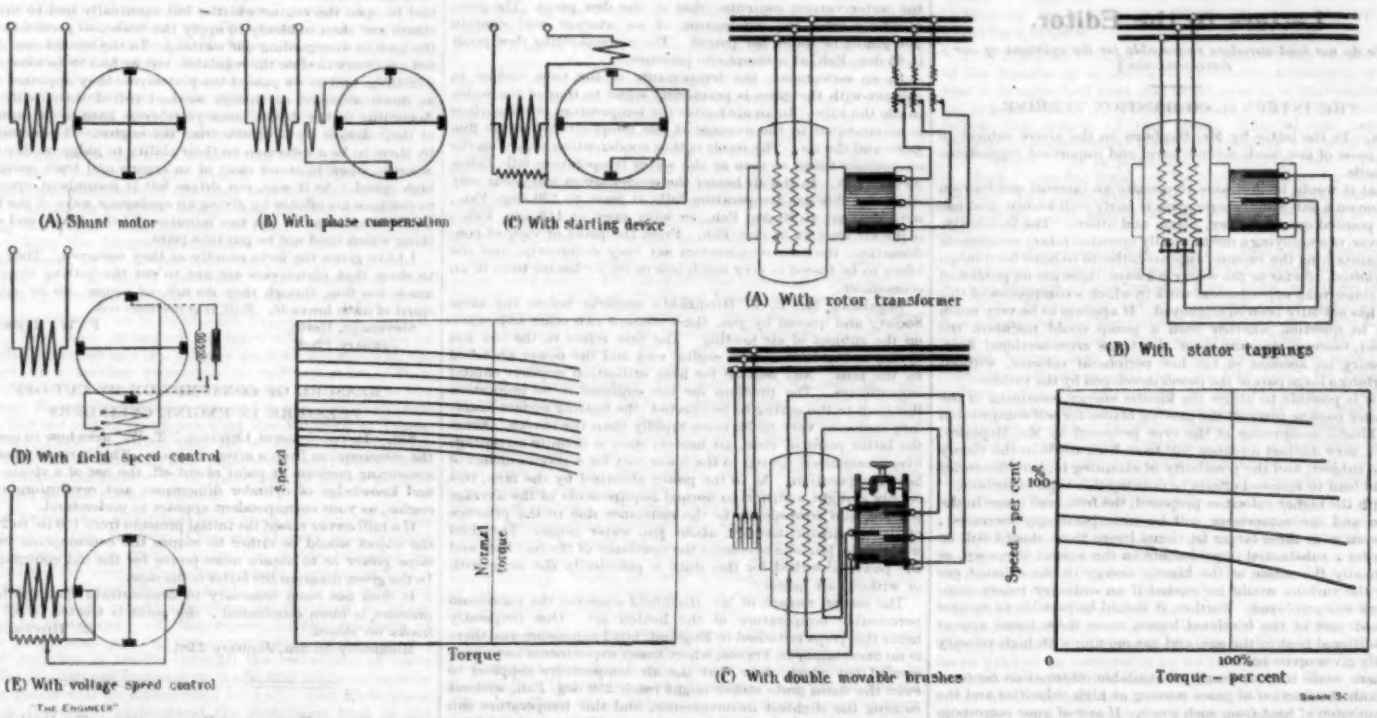


FIG. 2—SINGLE PHASE MOTORS WITH SHUNT CHARACTERISTICS

FIG. 3—THREE PHASE MOTORS WITH SHUNT CHARACTERISTICS

Motors with Series Characteristics.—The common method of controlling the speed of the three-phase series motor is by shifting the brushes. The direction of rotation depends on which side of the short-circuit axis the brushes lie, and is independent of the sense of the rotary field. When such a motor, with a fixed ratio of stator to rotor turns, is designed for a high power factor, instability occurs at low speeds. It is usually necessary to provide a transformer to obtain the low rotor voltage. (a) A main transformer, rated for the full power of the motor, is

(D) Combining the two stator windings in (C), the common repulsion motor with movable brushes is obtained. The brushes are in the short-circuited position when the brush axis coincides with the axis of the stator winding: and in the neutral position when the brush axis is perpendicular thereto. In both positions the torque is zero. Starting with the brushes in the neutral position, no starter is required. The line voltage is applied to the stator winding, and the motor begins to revolve in the opposite direction to that in which the brushes are moved. Here, then, both transformer and starter can be dispensed with.

(E) By splitting the brushes into a fixed set and a movable set, the brush shift is doubled, so that much finer speed regulation can be obtained. In addition to this refinement, no flux embraces the short-circuited coils when the brushes are in the neutral position.

Though not suitable for large variable-speed traction motors, the types (C), (D) and (E) are admirably adapted for small and medium outputs for industrial purposes, with speed ranges varying roughly from standstill to

usually necessary only for severe conditions. (*b*) A rotor transformer, rated for the slip power only, is all that is needed for many cases. By arranging that this transformer becomes saturated when the rotor voltage attains a certain value, *i.e.*, when a certain speed is reached, racing can be prevented. (*c*) Where stability over the whole speed-range and a high power factor are needed, the ratio of the stator to the rotor turns can be decreased, as the speed rises, by one-half of the brushes being fixed and the other half movable. Just as for general purposes the repulsion motor is the simplest type of single-phase commutator motor, so the three-phase series motor is the simplest type of three-phase commutator motor.

Motors with Shunt Characteristics.—The speed of the three-phase shunt motor is varied by supplying a pressure to the rotor brushes, and the brushes are rocked through 180 deg. to pass from sub-synchronous to hyper-synchronous speed. The connections are shown in Fig. 3. (A) A variable-ratio rotor transformer, capable of transmitting the slip power to or from the commutator brushes, fixes the speed at which the motor runs. A special connection can be used for altering the phase of the transformer voltage in order to raise the power factor. (B) It is sometimes possible to obtain the desired rotor pressure by taking tappings off the stator windings. (C) Where gradual speed control is required the brushes can be arranged in two equal sets, both being movable and connected to the separate stator phases. Power is supplied through slip rings to the rotor, while a special regulating winding may be employed as the commutator winding. Every brush position corresponds to a definite pressure and therefore to a definte speed.

In the previous types of three-phase shunt motor referred to, and in the three-phase series motors, the transformer E.M.F. becomes zero at synchronism, but in the present machine this E.M.F. remains the same at all speeds, because the frequency of the current in the rotor windings is always that of the supply.

In this respect the motor is similar to the single-phase series motor; but in the latter the transformer E.M.F. can be neutralised, whereas in the former it cannot be. It is further seen that the relative motion between the revolving field and the rotor is constant, and that this field is carried round by the rotor in such a manner that at synchronism the frequency of the E.M.F. induced in the stator winding is zero. By starting from the neutral position, a starter can be dispensed with, while phase compensation is obtained by shifting the two sets of brushes unequally. The direction of rotation of three-phase shunt motors is changed as in an induction motor, i.e., by reversing two stator leads.

The lecturer is greatly indebted to Mr. J. W. Sims, associate member, also to Messrs. M. G. Say, B.Sc., and R. E. Hopkins, B.Sc., post-graduate students at the City and Guilds (Engineering) College for their assistance in connection with the diagrams and experiments.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE INTERNAL COMBUSTION TURBINE.

SIR,—In the letter by Mr. Hepburn on the above subject in your issue of last week several novel and important suggestions are made.

That it would be desirable to operate an internal combustion turbine on a sub-atmospheric cycle is fairly well known, and has been pointed out by Davey, Stern, and others. The feasibility, however, of employing a mechanically operated rotary compressor for maintaining the vacuum appears hitherto to have been taken for granted. So far as the writer is aware, there are no published data concerning experimental work in which a compressor of this type has actually been so employed. It appears to be very much open to question whether such a pump could maintain the desired vacuum pressure over the large cross-sectional area, necessary on account of the low peripheral velocity, without absorbing a large part of the power developed by the turbine.

If it is possible to utilise the kinetic energy remaining in the gas after passing through the moving blades for self-compression in a kinetic compressor of the type proposed by Mr. Hepburn, then a very distinct advance will have been made in the theory of the subject, and the possibility of attaining higher efficiencies should lead to renewed efforts to develop this type of turbine.

With the higher velocities proposed, the frictional losses in the cooler and the compressor will be correspondingly increased; but even with these larger frictional losses there should still be room for a substantial improvement in the overall efficiency, as practically the whole of the kinetic energy in the exhaust gas from the turbine would be wasted if an ordinary rotary compressor was employed. Further, it should be possible to recover at least part of the frictional losses, since these losses appear as additional heat in the gas, and gas moving with high velocity readily gives up its heat.

There seems to be a dearth of available information concerning both the friction of gases moving at high velocities and the transmission of heat from such gases. If any of your correspondents could supply references to sources of such information, it would, I am sure, be appreciated by others as well as myself.

W. A. D. FORBES, R.C.N.C., A.M.I.N.A.

London, January 23rd.

SIR,—I was pleased to read Mr. Hepburn's interesting letter on the internal combustion turbine in your issue of January 20th, for it shows that there is still some interest being taken in a problem, the which, if solved, would revolutionise engineering practice in respect to the heat engine, a problem, which, I would add, was solved in all its essentials by Armengaud twenty years ago—not to mention Barber in 1791—and one in which Messrs. Holzwarth and Garuffa have laboured diligently since, in spite of the conservatism of English manufacturers. Mr. Hepburn, in his letter, suggests using the residual kinetic energy in the exhaust gases as an aid to compression (or exhaustion) in the rotary compressor. I fear, however, he tends to ignore the quantitative value of this method. Even with a residual velocity as high as .316 of the initial, only .1 of the kinetic energy in the working fluid is recoverable; and since, in the constant-pressure gas turbine, assuming achieved mechanical efficiencies, the positive work approximates to .4 of the positive work, the proportionate help provided is not great, even if practicable. The point raised, however, in respect of the reduction in the passage areas in the compressor due to this velocity is interesting and, as far as I know, original. It may be added, nevertheless, that the great objection to the rotary compressor lies in its high peripheral speed. Rateau gives the formula—

$$h = (\mu \rho u^2)/g,$$

where h is the pressure in kilogrammes per square metre, ρ is the density in kilogrammes per cubic metre, u is the peripheral velocity in metres per second, g is the acceleration due to gravity, and μ is a coefficient varying from .5 to .55.

If a lower rotational speed could be secured for a given compression ratio with these machines, it would aid greatly in the gas turbine problem.

I confess I do not understand clearly Mr. Hepburn's second suggestion regarding the production of vacua by induction. Such systems, though alluring, seem to be fundamentally inefficient on account of the kinetic energy loss involved. But perhaps I am mistaking his method.

In conclusion, I would point out that, from thermodynamical considerations and with the acceptance of admitted limits of temperature and mechanical efficiencies, the overall efficiency of the internal combustion turbine should lie between .25 and .35 for the constant-pressure type and between .3 and .4 for the constant-volume type. The difficulties in achieving these effects are almost wholly of a constructional kind, and it seems to me a matter of regret that the solution of a problem of this importance should be delayed in this country owing largely, I am convinced, to the fact that giving a dog a bad name has as damning an effect in the domain of experimental science as in any other branch of human activity.

January 20th. NORMAN DAVEY.

AIR HEATERS.

SIR,—In the article on "Developments in Power Station Design," No. XXI., in your issue of December 30th last, you quoted the opinion of Mr. J. S. Jacobus, as given in his paper on "Air Heaters" before the American Society of Mechanical Engineers, on the question of the harmful effect on air heaters of acids and moisture contained in the flue gases. This question merits most careful examination, because if the fear were well founded the use of air heaters might be most uneconomical, owing to high maintenance cost. In Europe, air heaters have been in operation sufficiently long to prove that such fears are not well founded.

Whilst on the Continent recently, I discussed your article with several specialists in these questions, and notably M. Emile Prat, who has designed some of the most important and successful installations in existence, and from the latter I learnt of several cases where air heaters have been in operation nearly ten years without undue deterioration.

The comparatively long life of thin plates, such as used for air heaters, might be surprising if one overlooked the fact that the action of condensation is very different from that of the feed-water economiser, and on which experience most of the criticisms on air heaters have been based. Condensation occurs when the temperature of the surface in contact with the flue gases falls below a certain value, depending on the pressure and the water vapour contents—that is, the dew point. The gases resulting from the combustion of an average coal contain 206 grains of water per pound. The corresponding dew point is 95 deg. Fah. at atmospheric pressure.

In an economiser, the temperature of the tube surface in contact with the gases is practically equal to that of the water inside the tube. In an air heater the temperature of the surface is about equal to the average of the temperatures of the flue gases and the air. The result is that condensation occurs on the economiser tubes as soon as the water temperature falls below 95 deg. Fah. In the air heater the condensation will occur only when the flue gas temperature falls at least to 130 deg. Fah., with cold air at 60 deg Fah., or with gases at 158 deg. Fah., if the air were at 32 deg. Fah. From the point of view of condensation, the two recuperators act very differently, and the effect to be feared is very much less in an air heater than in an economiser.

Regarding Mr. C. F. Hirshfield's remarks before the same Society and quoted by you, these contain two other objections on the subject of air heating The first refers to the low net saving owing to the extra capital cost and the power absorbed by the fans. Any scheme for heat utilisation requires capital expenditure. The problem for the engineer is to proportion this item to the saving to be effected; the heating surface necessary increases very much more rapidly than the saving. From the latter point of view, air heaters show a definite advantage over economisers, owing to the lower cost for a given amount of heat recuperation. As to the power absorbed by the fans, this is only a slight addition to normal requirements of the average scheme, and corresponds to the resistance due to the presence of the air heater, namely, about ½in. water gauge. The chief work of the fan is to overcome the resistance of the fuel bed, and the power absorbed for this duty is practically the same with or without air heater.

The second remark of Mr. Hirshfield concerns the maximum permissible temperature of the heated air. One frequently hears this point criticised in England, but I can assure you there is no uncertainty in France, where many experiments have been carried out which show that the air temperature supplied to even the chain grate stoker might reach 250 deg. Fah. without causing the slightest inconvenience, and this temperature can be appreciably increased for other types of automatic stokers.

It may be interesting to note that with air at this temperature, the increase in furnace temperature is not greater than that which would be produced by increasing the CO_2 by 1 per cent., a result which one would not hesitate to maintain if possible when working under ordinary conditions.

In conclusion, I suggest that it is very possible that the fears you mention are due to the fact that in the United States of America the experience of air heating is very limited, whereas in Europe it has been practised successfully and on a very large scale for several years.

S. UTTING, M.I. Mech. E., A.M.I.E.E.

London, S.W. 1, January 24th.

LOCOMOTIVES WITH FOUR EXCENTRICS.

SIR,—The four-excentric reversing gear fitted to Swiftsure, of the Liverpool and Manchester Railway, by Forrester and Co. in 1834, was a crude contrivance compared with the finished production of four-excentric reversing gear fitted to Comet, of the Newcastle and Carlisle Railway, by Hawthorn in 1835.

In your issue of March 2nd, 1883, you gave an incomplete drawing and a more incomplete description of the Forrester gear, both of which, you state, were received from Mr. Alexander Allan. It is stated:—"This improvement removed the constant rocking movement of the starting handles near to the engineman's position, and avoided the rough starting and shunting of engines at stations."

As a matter of simple fact, the Forrester gear had no feature in its construction that in any way whatever avoided rough starting and shunting at stations, while the means taken to remove the constant rocking parts from the proximity of the engineman were inferior to the simple long gap reach rods used on many of the loose two-excentric gears.

The fact that Mr. Allan was seventy-three years of age and in ill-health at the time he sent you the particulars may account for the unsatisfactory nature of your publication. To what circumstance the unsatisfactory nature of the Forrester gear is due can scarcely be determined now, and all the less easily when it is known that the William T. James drawings had been submitted to Forrester and Co. for business purposes. In any case Mr. Allan is not responsible. He was then only twenty-four years of age and had only two years of locomotive experience, which he commenced in Robert Stephenson and Co.'s employ in 1832. The Carmichael gear that was fitted to Swiftsure when rebuilt was also unsatisfactory in the respect of being disposed vertically, and consequently subject to distortion of motion through rise and fall of the axle.

It is a strange thing that the Carmichael gear with its fixed excentric and fork gabs did not receive earlier attention than it did. The value of the fork gabs was at once appreciated by Stephenson and Co. after their first use of a Carmichael gear in 1835, as may be understood from the fact that they built their first four excentric fork gab reversing gear in 1836.

On the other hand, as an instance of the inconsistency in locomotive practice of these days, Messrs. Naismith, Gaskell and Co., in 1841, built a number of engines similar to the Norris engines Philadelphia, &c., but instead of fork gab reversing gears, fitted palm gab gears, practically duplicates of the Hawthorn 1835 gear, which, of course, meant a return to the use of constant rocking starting handles. As if not quite satisfied with that as a retrograde movement, they provided each cylinder with a separate blast orifice in the chimney. You published an illustration of these engines about seven years ago.

If any of your correspondents can refer me to a source from which I can obtain full particulars of the Verpilleux steam tender locomotives built in 1842, I shall be much obliged. Engine and tender had outside cylinders, four-coupled wheels 4ft. 1½in. diameter at 5ft. 7½in. centres, and the boiler was a Cornish multitubular, with a steam storage chamber on top of it. These engines anticipate completely the Sturrock steam tender engines of 1864.

JAS. DUNLOP

Glasgow, January 21st

ACCIDENTS TO PLATELAYERS.

SIR,—Referring to your interesting article, it is certain that the mishaps to platelayers are largely due to the men's own indifference to danger, or, as I prefer to term it, to their own foolhardiness. I have often been on the footplate when the men have remained at their work until the last moment. I well remember two instances in particular. In both of these the men were made aware of our approach. In the first case we not only had to open the engine whistle, but eventually had to shut off steam and then suddenly to apply the brake, so persistent were the men in disregarding our warning. In the second case it was not necessary to close the regulator, but we had to do some sharp whistling, and as we passed the platelayers they appeared to be as much annoyed as though we had pelted them with coal. According to the driver, some platelayers hate to be reminded of their danger by a whistle from the engine. It is considered by them to be a reflection on their ability to judge, within a few seconds, when to stand clear of an engine and train moving at high speed. As it was, our driver felt it incumbent upon him to condone his offence by giving an apologetic wave of the hand. In the other case we lost two minutes and the driver said something which need not be put into print.

I have given the facts exactly as they occurred. They serve to show that platelayers are apt to cut the getting clear time much too fine, though they do not, of course, do so out of a spirit of mere bravado. Still, it is needless risk.

Stevenage, Herts, F. W. BREWER.
January 22nd.

MEASURE OF CONSUMPTION BY CUT-OFF PRESSURE IN ENGINE CYLINDERS.

SIR,—In your issue of 13th inst. "T. W." asks how to measure the consumption from a given diagram. This is readily done by measuring pressure at point of cut-off, the use of a steam table and knowledge of cylinder dimensions and revolutions of the engine, as your correspondent appears to understand.

If a mill owner raised the initial pressure from 150 lb. to 200 lb. the object would be either to reduce the consumption for the same power or to obtain more power for the old consumption. In the given diagram the latter is the case.

It does not seem necessary to demonstrate that the higher pressure is more economical; the point is treated in all text-books on steam. F. HOVENDEN.

Mundesley-on-Sea, January 23rd.

POST OFFICE ENGINEERS' EXAMINATION.—The Civil Service Commissioners announce that an open competitive examination for not fewer than fifteen situations as assistant engineer in the engineer-in-chief's department of the General Post Office will be held in London, Edinburgh, and Manchester in April next, commencing on the 20th of that month. Limits of age, 20 and 25, with certain extensions. Regulations and forms of application will be sent in response to requests by letter addressed to the Secretary, Civil Service Commission, Burlington-gardens, London, W. 1.

SCREW JACKS.—A well made type of screw jack, capable of lifting up to 75 tons and made in America, is being introduced into this country by the Duff Manufacturing Company, of Ulster Chambers, Regent-street, London, W. 1. It is provided with a steep pitch lifting screw, which can be quickly run up to its work by means of a winch handle and then screwed up to take the load by a long ratchet lever and toothed gearing. The quick-acting gear includes a worm and worm wheel of such a pitch that it is non-reversible, and this gear is clutched on to the main lifting gear so that it prevents the ram descending under the load when the ratchet lever is released. The load is controlled during lowering by the winch handle. The jacks are slightly more expensive than hydraulic jacks of the same capacity, but have the great advantage that less time is lost in raising the ram up to the point where it takes up the load, while they are, naturally, immune from freezing up.

Railway Matters.

THE local Whitley Councils provided for under the Railways Act, 1921, have now been agreed to and are to come into force at the beginning of April.

IT is announced that the Italian State Railways administration is desirous of receiving tenders for the electrification of the Bologna-Venice-Monfalcone line, which work is to be entrusted to private enterprise.

A RECENT poster issued by the Underground companies states that they employ 33,000 persons, and that they paid away, during the first half of last year, £3,600,000 in wages; 48 per cent. of the fares received is paid away in wages.

IN September last the goods receipts, less cost of collection and delivery, realised 3.303d. per ton-mile for general merchandise, 1.208d. for coal, coke and patent fuel, and 1.619d. for other minerals. The receipts for all classes of goods traffic averaged 1.998d. per ton-mile.

IN consequence of Mr. E. A. Watson, the chief mechanical engineer of the Great Southern and Western Railway, having resigned to become managing director of Messrs. Beyer, Peacock and Co., Limited, Mr. J. R. Bazin, the works manager at Inchicore, has been appointed to succeed him.

THE total number of persons employed on the American railways in the middle of July last was 1,634,872, as compared with 2,111,280 in July, 1920, a reduction of 22 per cent. The occupations have now been standardised in view of the establishment of a Railroad Labour Board and they number 148.

EARLY on the morning of the 9th instant, a goods train travelling between Rose Grove and Todmorden, on what has now become the London and North-Western Railway, became divided. When on the falling gradient near Portsmouth the rear portion, consisting of two wagons, two brake vans and a banking engine, ran into the first portion, causing thirty wagons to be derailed.

WHEN the licensing hours were extended the London Electric Railways put on some special late trains, leaving central points about twenty minutes after the last ordinary train. These were, we believe, intended for hotel and restaurant attendants to get home. The trains had been running for over two months, but as they did not receive sufficient public support they were withdrawn on and after the 14th instant.

WHEN the Electricity Commissioners were considering the scheme for South-East Lancashire in Manchester last week, the question of including Buxton and district therein, instead of in the Sheffield area, was mentioned, and the chairman, Sir John Snell, reminded the Town Clerk of Buxton of the possibility of the railway between Manchester and Buxton being electrified—a possibility which lay, he thought, within the limits of practical politics.

THE warehouse in the North British Company's goods yard at Glasgow College Station was destroyed by fire on Friday last. This station, usually known by the name we give, but officially called High Street, is one of the best arranged in this country. It was remodelled about fifteen years ago. The main building is three storeys high, with a basement in addition. It is 490ft. by 315ft. and served by nine platforms, and was remarkable for its electrical equipment of cranes, hoists, traversers and capstans.

IN giving evidence for the Scottish railway companies before the National Wages Board, Mr. Killin, the Caledonian superintendent of the line, was questioned by Mr. J. H. Thomas as to there being more dangers in shunting during the night than during the day. Mr. Killin said that, taking the hours of daylight together there were 219 accidents, or 60.33 per cent., and during the hours of darkness 144, or 39.67 per cent. The questions were inspired by the men getting time and a-half for night duty.

A CONFERENCE, to be held next Tuesday week, the 7th prox., has been arranged between the Federation of British Industries and the railway general managers on the subject of a further reduction in railway rates. It is said that it is hoped thereby to avoid an appeal to the Railway Rates Tribunal set up under the Railways Act, 1921, but we would point out that the Ministry of Transport Act, 1919, provided that for eighteen months after the cessation of control, i.e., until February, 1923, rates shall remain unaltered. It is, therefore, no use at present to appeal to the Rates Tribunal.

THE Federation of British Industries has written to the secretary of the Railway Clearing House, stating that when a deputation waited upon the goods manager on November 18th very definite statements were made that a reduction in railway charges would result in (1) retaining rail traffic which would otherwise be diverted to other means of transport; (2) the return to the railways of traffic at present passing by other means of transport; (3) an increase in traffic through the reduction of costs and the consequent increase in trade and in the area over which goods will be distributed by rail. The Federation cannot, therefore, understand the statement that to the deputations which have been received by the companies no assurance was given nor any confident expectation expressed that reduced rates would result in an immediate increase in traffic.

THE electrification of the Bombay suburban lines of the Great Indian Peninsula Railway has not yet been commenced. The chairman of the company, speaking at the half-yearly meeting on the 20th instant, said that all the preliminary work was completed and that the company was quite ready to go ahead when the necessary funds could be found, but from the latest news to hand no funds for this purpose were likely to be allotted for some years. If, as is likely, the Government of India was unable to help, it would not, the chairman thought, be difficult to arrange a satisfactory financial transaction in this country by which payments would be spread over a period of several years. The importance of the work was very urgent, as it would not only reduce the cost of working, but would be of material assistance to Bombay in the years to come in helping to move expeditiously its rapidly increasing population, which will have to live at some distance from the city.

Notes and Memoranda.

TESTS made in America by the National Tube Company and others show electrolytic iron to have a yield point of 52,000 lb. per square inch, and an ultimate strength of 40,000 lb. to 80,000 lb. per square inch, depending upon the heat treatment. The sclerescope hardness was 27, dropping to 11 on re-heating. The Brinell hardness was 158, dropping to 54. The elongation was 12 per cent. on an 8in. strip, and the reduction of area 50 per cent.

THE report has been issued of the preliminary inquiry into the causes of an explosion from a vertical cross tube boiler at the Park Slip Colliery, Park Farm Drift, Aberkenfig, of North's Navigation Collieries (1899), Limited. The observations of the Engineer Surveyor in Chief to the Board of Trade are to the effect that the explosion was the result of the failure of a welded steel tube under ordinary working conditions. The failure was probably due to a latent and unsuspected defect in the weld or in the metal in its vicinity.

THE Borough of Islington will shortly have one of the largest municipal fleets of electric vehicles in the Metropolis. In March last, eleven vehicles were acquired for the purpose of watering the streets and collecting refuse, and now four more 2½-ton electric dust vans have been purchased. A report states that, in the Council's experience, one motor vehicle is equal to two horse-drawn vans for dust collection, and to four horse-drawn vehicles for street-watering, and therefore a large economy is effected by using electric vehicles instead of horses.

THE United States coastguard cutter Tamoa, the first of four electrically-driven cutters to be placed in service by the Treasury Department, has just been delivered to the authorities at the port of New York. She was built by the Union Construction Company, Oakland, and is 240ft. long, 39ft. beam, 25ft. 6in. deep, displaces 1600 tons at a mean draught of 14ft., and has a speed of 16 knots. The main propelling machinery consists of two Babcock and Wilcox water-tube boilers burning oil, which supply steam to a turbine-driven alternating-current generator. This in turn operates a 2600 horse-power synchronous motor at a propeller speed of 130 revolutions per minute.

IN describing the new lighting installation in a park at Cleveland, U.S.A., the *Electrical World* mentions an interesting safety device. The roads that are lined with the ornamental lamp-posts are somewhat curved. In the past it has sometimes been found that with curved roads in the event of a particular lamp becoming extinguished a driver may fail to see the post and run into it. Accordingly in each standard there is a coloured glass bull's-eye, about 6ft. up, behind which is a small lamp in parallel with the main lamp on the transformer circuit. So long as the main lamp is burning the voltage of this signal lamp is so reduced that there is barely a visible glow. But if the main lamp burns out the signal lamp glows brightly and makes the presence of the standard evident.

ONE of the earliest steam vessels in the East was, according to the *Indian and Eastern Engineer*, one which was taken to Calcutta by Captain Davidson in 1818. It was of 8 horse-power, but its merits do not appear to have been appreciated, for it was allowed to remain unused till 1822, when it was eventually fitted up in a Government dredging boat, and afterwards converted into a floating battery in the expedition to Arracan. It is a curious fact, however, that the first vessel propelled by steam in India was built for the King of Oudh as a yacht. The plans and engine were taken out in 1819; the latter (made at the Butterley Works) was a single 3 horse-power engine, capable of moving the vessel at 7 to 8 miles an hour. This little steamer, a toy of the King's, was, like others of his playthings, soon laid aside, and suffered to fall into decay.

STANDARD transformers, states Mr. J. G. Gorrin in a paper read before the Philadelphia section of the Association of Iron and Steel Electrical Engineers, are so designed that they can, when necessary, be operated at a voltage not to exceed 10 per cent. in excess of normal. Increasing the impressed voltage by 10 per cent., increases the iron losses approximately 20 per cent. and the magnetising current approximately 100 per cent. Ordinarily, the magnetising current of power transformers varies between 4 per cent. and 12 per cent. of full load current for single phase units. In particularly well-designed transformers, the magnetising current is as low as 1 per cent. of full load current. On three-phase transformers, the phase magnetising current is from 1 per cent. to 12 per cent. of full load current. In any three-phase transformer, the phase magnetising currents are not the same, but vary with respect to each other. This is due primarily to the usual unbalanced magnetic circuit found in three-phase transformers. Some recently developed commerical lines of three-phase transformers have materially reduced the magnetising current between phases.

RATHER interesting results were obtained from a competition for aluminium alloy pistons organised by the Department for Aerial and Motor Vehicle Transport in Germany. Thirty-two sets of pistons made out of sixteen different alloys were entered by nine firms, and the tests were carried out at the Motor Vehicle Laboratory of the Berlin Technical College. The first prize was won by the Griesheim-Electron Chemical Works with an alloy consisting of 87 per cent. magnesium and 13 per cent. copper; second was Karl Schmitz with an alloy of aluminium and copper cast in metal moulds. The winners of the first place also gained third position with an alloy of 88 per cent. magnesium and 12 per cent. aluminium. The sets of pistons were tested in a 10 to 30 horse-power touring car engine and in a 35 horse-power motor lorry engine. Besides dynamometer tests, trials were made of the heat conductivity and the capacity for heat absorption of the various alloys. During the brake tests an attempt was made to determine the best compression ratio for use with aluminium pistons, and this led to the conclusion that for power output and fuel economy a ratio of 5.7 to 1 was the best. In the case of the motor lorry engine 21 per cent. more power was developed than with grey iron pistons, and 20 per cent. less fuel per horse-power hour was consumed. In the case of the touring car engine the power output was increased by 5 per cent., and the saving in fuel amounted to 13 per cent., but this engine was of the side valve type with a flat compression space.

Miscellanea.

AN exhibition devoted to the "Utilisation of Electric Power" is to be held in Christiania from April 22nd to May 7th, 1922. Foreign as well as Norwegian exhibits will be admitted.

IT is officially reported from Washington that negotiations have begun between the United States and Great Britain on the proposed waterway between the Great Lakes and the St. Lawrence, it being believed that some international agreement should be reached before any action was taken by Congress.

A LARGE project is in course of development, according to *Indian Engineering*, for bringing water to Singapore from the State of Johore, crossing the Straits of Johore over the causeway which is now in course of construction. There is also under consideration a plan for developing a water supply in the State of Khedah.

PROSPECTING operations have recently been in progress near Vogelgenas, about 19 miles from Britstown, on the De Aar-Prieska line, for coal. A large acreage of ground has been taken up under option, says the *South African Mining and Engineering Journal*, and a shaft has been sunk to a depth of over 50ft. through shales to a band of carbonaceous shale.

THE Legislative Assembly at Delhi, on January 12th, accepted the resolution of Sir P. Sivaswamy Aiyer in favour of the formation of a mixed committee to propose measures for the recruitment of Indians as executive and engineer officers in the Royal Indian Marine, for the encouragement of shipbuilding, for the establishment of a nautical college, and for the construction of dockyards in India.

IN the Spanish lead ore trade a great decrease in the sale of lead ore to the advantage of zinc ore is feared as a result of the measures for the restriction of the use of white lead passed at Geneva by the International Labour Bureau. No one in Spain appears to have taken any interest in the matter except the Bureau of Social Reform, which agreed with the proposals for restriction without informing interested parties.

OPPOSITION will be offered by the District Councils of Millom, Bootle, and Dalton to the North Lancashire and South Cumberland electricity scheme at the forthcoming Government inquiry at Barrow. Alderman Lowthwaite (Cumberland County Council) and Mr. Hodgson (the clerk) will testify against the scheme. Millom's counter-proposal is to establish a local electricity supply from surplus heat from the local ironworks.

THE linking-up agreements which are being arranged by Blackburn, Preston and Accrington are designed to effect the electrification of a populous and important area of Lancashire. In the district within the areas of the municipalities concerned, there are about 700 cotton mills and a population of over a million. Large expenditure is involved, it being estimated that the cost of a linking-up cable between Blackburn and Preston will alone be £138,000.

IT is reported that an extensive plan for the canalisation of the Moselle up to the German frontier is being prepared, and it is expected that the total cost of construction will be not less than 77 million francs. The canal will not follow the course of the river. The section between Metz and Diedenhofen (Thionville) will have four locks and five "ports." It is proposed to construct two "ports" at Metz; one for local traffic and the other for through traffic. The locks are to be 115ft. long, 40ft. wide and 8¼ft. deep. The height of the bridges has been fixed at 16½ft.

THE recommendations of the Research Committee which was appointed to consider the design of cylinders for the storage of compressed gases have just been issued by H.M. Stationery Office. Among other innovations, it is suggested that the steel of which they are made should have the following characteristics:—The yield stress should be not less than 20 tons per square inch; the maximum stress should be not less than 40 tons per square inch; the elongation on the 6in. gauge length of the specimen should be not less than 14 per cent.; the maximum working pressure should be 120 atmospheres, or 1800 lb. per square inch, until there is a general agreement amongst gas compressors that a higher limit is desirable; the stress due to working pressure should not exceed 10 tons per square inch.

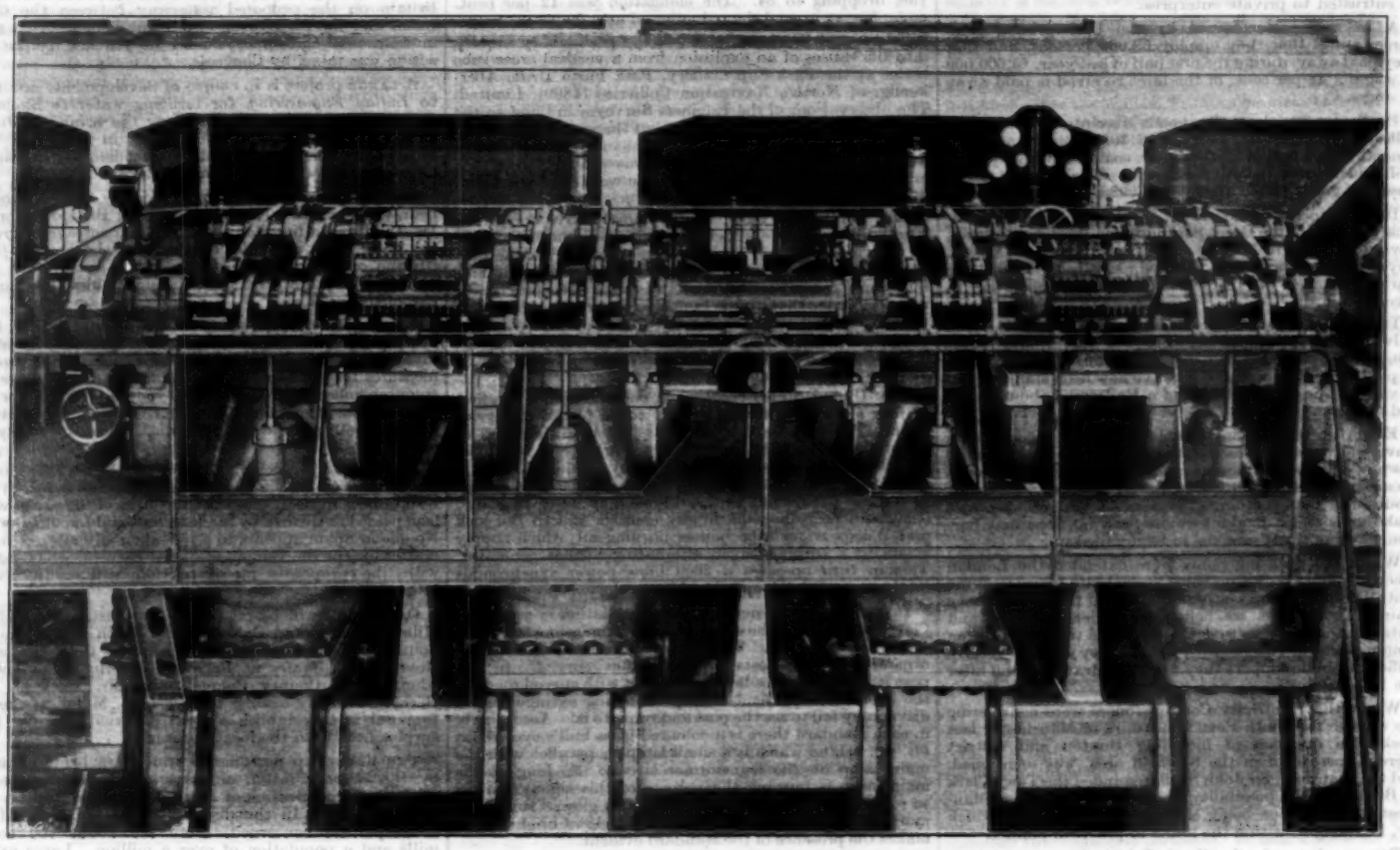
THE question of the introduction of liquid air explosives as a substitute for gunpowder in ironstone mining is engaging the attention of Cleveland ironmasters, according to the *Chemical Trade Journal*. The method has been in operation from time to time in America and Germany for many years. Recently, however, great improvements in the method of employing liquid air have been made in experiments in the ironstone mines in Lorraine, and they have proved so successful as to put the use of liquid air explosives beyond the experimental stage. Two deputations of Cleveland ironmasters visited Lorraine a short time ago and witnessed the use of these explosives in operation. They were so satisfied with the result of their investigations that they have arranged for a series of demonstrations in the Cleveland mines.

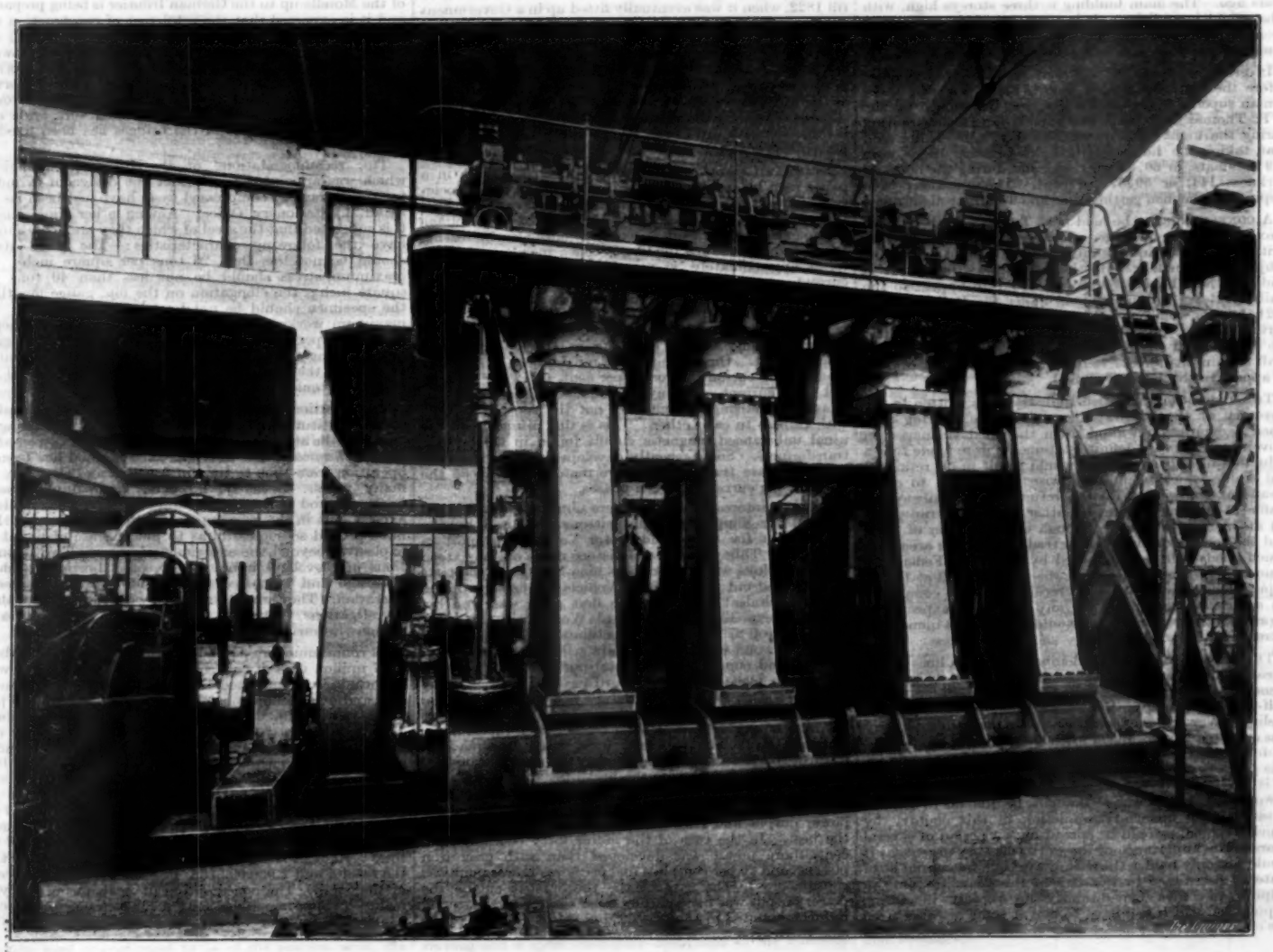
IN round numbers, Canada produced during 1920 about 16.7 million tons of coal, of which 2.6 million tons were exported; and imported 12.9 million tons of bituminous coal and 4.9 million tons of anthracite. During the previous year, 1919, Canada produced, in round numbers, 13.5 million tons of coal, exported 2 million tons, and imported 12.3 million tons of bituminous coal and 5 million tons of anthracite. The total production in 1920 included 115,679 tons of anthracite, or about 1 per cent. of the total; 12,865,851 tons of bituminous, or 77.4 per cent. of the total; and 3,610,424 tons of lignite, or 21.7 per cent. of the total. The total production in 1919 included 111,324 tons of anthracite, or less than 1 per cent. of the total; 10,642,902 tons of bituminous, or 77.8 per cent. of the total; and 2,926,992 tons of lignite, or 21.4 per cent. of the total. The consumption of coal during the year included approximately 5,036,992 tons of anthracite, 24,084,105 tons of bituminous, and 3,610,424 tons of lignite.

1600-B.H.P. NOBEL-DIESEL MARINE ENGINE

SVENSKA AKTIEBOLAGET NOBEL-DIESEL, NYNASHAMN, SWEDEN, ENGINEERS

(*For description see page 91*)





AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND Co., Bombay; THACKER AND Co., LIMITED, Bombay; THACKER, SPINK AND Co., Calcutta.
ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
JAPAN.—MARUZEN Co., Tokyo and Yokohama.
AFRICA.—WM. DAWSON AND SONS, LIMITED, 7, Sea-street (Box 49), Capetown.
C. JUTA AND Co., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—GORDON AND GOTCH, LIMITED, Melbourne Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND Co., Gresham-street, Adelaide.
CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street, East, Toronto.
GORDON AND GOTCH, LIMITED, 132, Bay-street, Toronto.
MONTREAL NEWS Co., 386-388, St. James-street, Montreal.
TORONTO NEWS Co., 42, Yonge-street, Toronto.
CEYLON.—WIJAYARTNA AND Co., Colombo.
JAMAICA.—EDUCATIONAL SUPPLY Co., Kingston.
NEW ZEALAND.—GORDON AND GOTCH, LIMITED, Wellington and Christchurch; UPTON AND Co., Auckland; J. WILSON CRAIG AND Co., Napier.
STRAITS SETTLEMENTS.—KELLY AND WALSH, LIMITED, Singapore.
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS Co., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS Co., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—BRITISH AND COLONIAL PRESS, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—AGENCE VOX, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer.

526, Rolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.
Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.
If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly ..	£1 11s. 6d.	Half-yearly ..	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 16s. 6d. per annum.
Thick paper edition .. £3 3s. 0d. „

ADVERTISEMENTS.

**** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication) ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of THE ENGINEER.

Postal Address, 35, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, January 27th, 1922. PAGE

THE MAINTENANCE OF TIDAL BERTHS. (Illus.) 87
SANITARY ENGINEERING IN 1921 88
1600 B.H.P. NOBEL-DIESEL MARINE ENGINE.—No. I. (Illus.) .. 91
ELECTRICAL ENGINEERING IN 1921.—No. II. 94
THE INSTITUTION OF CIVIL ENGINEERS 96
COMBATING AN EFFECT OF THE DROUGHT 96
A SEVEN-DAY JOURNAL 97
INSTITUTION OF MECHANICAL ENGINEERS 98
SINGLE AND THREE-PHASE ALTERNATING-CURRENT COMMUTATOR MOTORS WITH SERIES AND SHUNT CHARACTERISTICS. (Illus.) 98

LETTERS TO THE EDITOR—
The Internal Combustion Turbine 100
Air Heaters 100
Locomotives with Four Excentrics 100
Accidents to Platelayers 100
Measure of Consumption by Cut-off Pressure in Engine Cylinders 100

RAILWAY MATTERS 101
NOTES AND MEMORANDA 101
MISCELLANEA 101

LEADING ARTICLES—
Recent Sewage Treatment Methods 103
Alternating-current Commutator Motors 104

THE ELECTRIFICATION OF ENGLISH MAIN LINE RAILWAYS 104
BOOKS RECEIVED 105
TUG WITH GRAIN SHIP DISCHARGING PLANT. (Illus.) 109
LAUNCHES AND TRIAL TRIPS 109
THE UTILISATION OF EXHAUST STEAM 109
SOUTH-EAST LANCASHIRE ELECTRICITY SCHEME 110
PERSONAL AND BUSINESS ANNOUNCEMENTS 110
ANGLE COMPOUND AIR COMPRESSORS AT A COLLIERY. (Illus.) .. 111

PROVINCIAL LETTERS—
The Midlands and Staffordshire 112
Lancashire 113
Sheffield 113
North of England 114
Scotland 114
Wales and Adjoining Counties 115

LATEST NEWS FROM THE PROVINCES 115
SURVEY OF THE NATIONAL COAL RESOURCES 115
CALENDARS, DIARIES, &C. 116
CURRENT PRICES FOR METALS AND FUELS 116
FRENCH ENGINEERING NOTES 117
BRITISH PATENT SPECIFICATIONS. (Illus.) 117
FORTHCOMING ENGAGEMENTS 118

PARAGRAPHS—
Municipal Electrical Old Stagers' Reunion 112
Institute of Metals 112
Farewell Dinner 118
Contracts 118

THE ENGINEER.

JANUARY 27, 1922.

Recent Sewage Treatment Methods.

THOSE who know most about the treatment of sewage would be the last to say that finality had been reached in any method of disposal and purification hitherto introduced. Yet it almost seemed, a few years back, as though it were not possible to go much farther. The development of the percolating filter-bed had rendered possible such a high degree of purification that, to many, it appeared unnecessary that anything more should be done. Even sewage heavily charged with trades wastes proved amenable to adequate treatment, and final effluents, which were in many cases of far higher purity than was actually necessary, could be produced. The percolating bed at once reduced very considerably the area required for the purification of any given volume of sewage, and sanitary engineers no longer found themselves obliged, as they sometimes were in former times when land treatment was imperative, to do the best they could with soils entirely unsuited for irrigation with sewage. The sludge problem was, it is true, always there, but it was tackled with varying success by different methods, and was looked upon, in any case, as a necessary evil which had to be put up with. In special cases, as, for example, at Bradford, it contained so much fatty matters that it became a paying business to extract them, and the residual material was more readily employable as manure than are some sludge cakes produced by ordinary methods. In brief, the treatment of sewage by sedimentation, and, if necessary, precipitation, followed by spraying over filter-beds, seemed almost to have solved all the troubles which had up till the time of its introduction been experienced.

The sanitary engineer, however, refused to rest on his laurels. He went on experimenting. The beneficial effects of aeration under certain circumstances had been early observed, and it was in the direction of increased aeration that the next advance was made. The Activated Sludge system of treatment, with the original development of which the names of Fowler, Mumford, Ardern and Lockett are intimately connected, created a considerable stir throughout the world. In this country events did not march quite so quickly as in other countries—notably the United States—because its discovery was made just prior to the war, but considerable progress was made during the period of hostilities in connection with putting the process on a practical basis, and since the Armistice matters have been further advanced. There are numerous activated sludge plants at work throughout the country producing excellent results, and Reading is now engaged in laying down works to treat the whole of its sewage on that system. Working independently at Sheffield at the same time as or even prior to the first activated sludge investigations, Messrs. Haworth and Hodgkinson were also experimenting with aeration by various means, the object being to render the effluents from existing primary contact beds satisfactory to the Rivers Authority. These two investigators found that the character of the Sheffield sewage was such that, if the process depended upon the forcing of air through small orifices, then it was not possible to employ it at Sheffield. Air blown into sewage performs two functions. It stirs up the sludge with the sewage, and it supplies oxygen to maintain the biological life on which the purification depends. It was ascertained that by far the larger proportion of the air was consumed in the work of agitation, and Messrs. Haworth and Hodgkinson set themselves to devise a method of mechanical agitation in the hope that with it a much smaller amount of air would suffice than had up to then been found necessary. They succeeded so well by means of revolving paddle wheels that not only was the agitation satisfactorily performed, but it was found that there was sufficient aeration to effect purification without the necessity of using pressure air as well. Well-oxidised non-putrescible effluents are produced and subsequent treatment in percolating filters is not required. As filtration is not necessary for the effluents from activated sludge treatment tanks, it would seem that both processes show a considerable advance on pre-existing methods from the point of view of the area of land necessary for purifying a given volume of sewage. As is nearly always the case with any discovery, more persons that one happen to be experimenting more or less in the same direction. It was so with the two processes to which we have just alluded, and their originators were not alone. Walshaw, of Parramatta, was also trying what he could do with aeration, and his method was to force a given amount of air into sewage as it was led into a closed tank, his object being twofold: to purify the sewage and to obtain as much gas as possible from the sewage. Practically at the same time Hilder Daw in this country was devising a means for allowing the sewage to fall through an air blast so as thoroughly to aerate it. In both these last two processes, which have been so recently referred to at length in our columns that they need not be further described now, in addition to the production of an effluent which is in specially good condition for subsequent treatment, a considerable diminution of sludge as compared with other methods is claimed, and in the case of the first the production of large volumes of gas of high calorific value as well.

It is evident from what has been said that sewage disposal matters are by no means standing still; indeed, they may well be said to have recently made considerable advances. It is no small thing to have reduced the area of land required for a process which, though absolutely necessary, is in the majority of cases at the present time not only non-productive, but actually costly. Recent developments, however, would seem to point to a possibility that, in future, the disposal of sewage may not always be the expensive business it has hitherto, with one or two notable exceptions, been. It is, apparently, by no means beyond the bounds of possibility that, in future, not only may a sewage works pay for itself, but that it may even have a surplus of energy to dispose of in other directions. The question of utilising the gases developed in the sewage and sewage sludge has, during the year, attracted a no inconsiderable amount of attention. It is, of course, no new knowledge that sewage gives off gas, but it is also true that up to quite recent years no great use was made of that knowledge. For some years past, however, engines driven by sewage gas have been in successful operation in Australia under the Walshaw system, and during the past year Mr. Watson has been running a gas engine at Birmingham with gas obtained from a specially constructed tank somewhat on the lines of that introduced by Mr. Walshaw. Now, it appears from experience gained in Australia that for every 1000 persons 9 continuous brake horse-power can be depended upon, while Mr. Watson calculates that a volume of sludge containing two tons of dried solid matter will produce enough gas to work a 25 horse-power gas engine for six hours. It would be going too far, of course, to anticipate that in the near future every sewage works in the kingdom will become, by the sale of the power produced from its gas, a financial asset instead of, as at present, a liability; but it does not seem to be too much to hope that the

subject may receive more serious attention than it has since Mr. C. C. James first worked an engine with sewage gas some fifteen years ago.

Alternating Current Commutator Motors.

IT is surely time that more consideration was given in this country to the possibilities of single-phase and polyphase commutator motors, which are now utilised fairly extensively on the Continent and in America. Among the early inventors in this field were Professor Ernest Wilson, Mr. Ll. B. Atkinson, and, later, Mr. F. Creedy, who is the originator of an exceptionally good machine with shunt characteristics, but for the most part the work of developing these alternating-current commutator motors has been left to American and continental engineers. For the past fifteen years or so but few British engineers, apart from Mr. F. Creedy, seem to have paid very much attention to the matter, and Dr. Stanley Parker Smith's lecture on the subject, recently delivered before the Institution of Electrical Engineers, of which an abstract is given elsewhere in this issue, was quite an unusual event. Never, as far as we can remember, has there been more plain speaking concerning the use of single-phase current for working trains. Mr. Atkinson, who, as far back as 1898, read a paper on alternating-current commutator motors before the Institution of Civil Engineers, and whose early work in this connection is now universally recognised to have been of considerable importance, was loud in praise of Sir Philip Dawson's advocacy of the single-phase system on the Brighton Railway. Sir Philip, he said, was the only engineer who had had the foresight and courage to use that system on an extensive scale in this country, and although that method of electrifying railways was not at present generally accepted, he believed that it would be in due course. A noteworthy feature of the meeting was that although in the past single-phase traction has met with considerable opposition, no one who took part in the discussion had anything to say against it. Had Dr. Smith merely dealt with the theory and construction of alternating-current commutator motors, this lack of adverse criticism would not have been surprising, but as he took particular pains to point to their advantages and to the backward state of our knowledge relating to these motors and their application to railways, it seemed that either the opponents of single-phase traction were absent or that they have ceased to exist.

It is known, of course, that the Railway Electrification Advisory Committee has standardised the 1500-volt direct-current system. The wisdom of that Committee's decision has, however, been questioned by more than one eminent authority, and it would be interesting to know to what extent this standardised pressure is likely to be adopted. In the first place, there are, as is well known, various electric railways which are working at different pressures, and which are not to be interfered with. Moreover, Sir Philip Dawson explained, in the course of the discussion on Dr. Smith's lecture, that he only signed the Railway Electrification Advisory Committee's report because it left a loophole for a railway that did not wish to use the standardised system to apply to the Minister of Transport for permission to use something else. It appears, therefore, that the 1500-volt direct-current railway is not really standardised. When certain cases of electrification are carefully considered it will, we fancy, be found that a pressure ten times greater than 1500 volts will be beneficial. As a result largely of the activities of Mr. H. M. Hobart and a few other enthusiastic advocates of direct current, certain railway engineers appear to have the belief that the use of any other system in this country is out of the question. From the point of view of the super power station promoter, who wants to sell 50-cycle current, the direct-current railway offers a better field than the single-phase railway, which cannot, unless frequency changers are used, take current at a higher periodicity than 25 cycles. But each railway must at all costs have a system adapted to its requirements, and if the proper current for that system cannot be purchased from the super power stations, then the railway must have the right to generate the current itself. Before the war we published a series of articles on single-phase electric railways with a view to showing what had been done abroad, but since then much additional work has been undertaken, and those articles do not by any means represent the position of the single-phase system at the present time. In Switzerland, Sweden, Germany, Austria and Norway single-phase current is being used exclusively for railway electrification. For long-distance work this system is at present employed more extensively than any other system, although there are, of course, a good many so-called high-tension direct-current railways.

It may be imagined that as the Railway Electrification Advisory Committee has recommended the adoption of 1500-volt direct-current working any attention on the part of electrical manufacturers to the single-phase system is uncalled for. Such a conclusion, however, is obviously erroneous. Even if it could be shown that all railways in this country can be worked most economically with direct current, it is to be remembered that there are many railways to be electrified abroad, and nothing is more unlikely that all of those lines will be worked with direct current. Continental and American firms have spent large sums of money on single-phase experimental work, whilst our firms have, in comparison, apparently done next to nothing. The acquisition of single-phase experience is, however, now very essential to British electrical manufacturers, and there is no doubt that Dr. Smith was right in advocating that the single-phase system should be extended to Brighton as soon as possible, and that the work should be done by British firms in order that they might acquire the experience which is necessary to enable them to compete with other firms in connection with work elsewhere. The possibilities of the alternating commutator motor for general power purposes should also be kept in view. Much is heard in these days about the low power factor of alternating-current systems, but the question of using motors other than those which give rise to the trouble is rarely discussed. Polyphase commutator motors and synchronous induction motors, as recently described in a paper read by Mr. Carr before the Institution of Electrical Engineers, will do much to relieve electricity supply mains of wattless currents. Again, from the point of view of speed regulation, the commutator machine, though perhaps somewhat expensive, is more satisfactory than the ordinary induction motor, although it must not be forgotten that a very ingenious variable-speed induction machine has been invented by Mr. F. Creedy. One of the main things to be aimed at in the future is, it would seem, to avoid as far as possible the practice of converting current for general power purposes. The amount of money that has already been spent on converting plant must be tremendous, and it would seem to be most desirable in present conditions, when economy is so essential, to eliminate in every possible instance the use of that form of machinery.

The Electrification of English Main Line Railways.

A JOINT meeting of the Midland Branch of the Institution of Mechanical Engineers, the Birmingham and District Association of the Institution of Civil Engineers, and the South Midland Centre of the Institution of Electrical Engineers, was held in Birmingham, on the 20th inst., to discuss "The Electrification of English Main Line Railways."

Sir Henry Fowler, who occupied the chair, said that at no time could a discussion on the subject before the meeting be more opportune. If questions of cost were neglected, electrical and mechanical difficulties were few. Mr. A. W. Gibbs, Chief Mechanical Engineer of the Pennsylvania Railroad, in 1907, determined the effect of steam and electric locomotives on the road itself, by measuring the indentations made by hard steel balls on a steel strip. Roughly he concluded that the best arrangement was a high centre of gravity, and unsymmetrical wheel base. He had recently informed Sir Henry that nothing had occurred to change their views concerning the disadvantages of a low centre of gravity, and the short wheel base truck, as an unsuitable arrangement. For lines having a low density of traffic, Sir Henry continued, the first cost of electrification was a very serious consideration, for the expenditure was high, and the annual charges were heavy. Granting that electrification was desirable with dense traffic, it was essential to know how dense it must be to make it pay.

Mr. H. N. Gresley, of the North Eastern Railway, observed that the electrification of railways had been strongly urged as a means of enabling railways to pay their way and reduce their working expenses. Unquestionably the electrification of sub-service and suburban railways carrying a dense passenger traffic had achieved successful results. He suggested, however, that the problem of main line electrification was a totally different and much more difficult matter. It could not be urged that the main lines were congested, and it did not therefore appear that a huge expenditure on their electrification would give a commensurate return. Even if the trade of the country improved to such an extent as to necessitate the doubling of the main line, and the provision of more locomotives, the question of the electrification of main lines would still require very serious consideration. During the past year several papers had been read on the subject, but, in his opinion, it was to be regretted that in some cases the authors were carried away by their enthusiasm into making comparisons between the best results that could be expected from electrification and the average results at present being obtained by steam traction, which included the results derived from engines in service for upwards of twenty or thirty years. Moreover, the comparisons made referred principally to the cost of fuel and repairs, little mention being made of the cost of electrical equipment of the lines with sub-stations, third rails, or overhead transmission. No mention was made, either, of the extra cost of maintenance involved by the existence of third rails or overhead wires, and, in the former case, the extra cost of maintenance of the running track caused by the presence of the third rail. It was stated recently that the cost of electrifying a railway was something like £20,000 per mile, this sum including the provision of a third rail, sub-stations, power station, and also the electric locomotives. The figure was for a very dense traffic, and was based on the costs prevailing some twelve or fifteen years ago. It was suggested that probably the figure was double to-day. But taking the figure at £20,000 per mile, and the weekly receipts per mile at £106, the yearly receipts were about £5000 per mile, and the interest at 5 per cent. per annum was £1000. If 20 per cent. of the earnings was to be absorbed in paying interest on the capital expenditure on electrification it seemed to him to be somewhat difficult to make out a strong case. He was strongly in favour of the electrification of suburban railways, and of railways on which it was necessary to spend a large amount of money in doubling the lines. For long lines of railways, with traffic which was not dense, and with comparatively infrequent services of trains, it appeared to him that unless the cost of electric supply could be reduced very much below the present level, there was not likely to be sufficient financial return for the money which would be involved in carrying out the scheme.

Mr. W. Willox, M. Inst. C.E., formerly chief engineer of the Metropolitan Railway, said that in economical working the electrical locomotive had proved itself superior to the steam locomotive. When the Electricity Commissioners had fixed the position of the large power stations, those railways that decided on main line and suburban electrification would be saved the cost of providing power for themselves. The cost of the electrification on such railways as the Metropolitan, including power house and everything, was somewhere about £20,000 a mile at pre-war values. The cost of electrifying the East London Railway, which obtained current from Lots-road, was about £5400 per mile at pre-war value. This figure included one new sub-station, conductor rails and improvements to the permanent way. The cost of ordinary maintenance of a rail contact line was found to be £12.64 per mile per annum. On the West London line maintenance amounted to £13.1 per mile per annum. With power supplied for electrification, the signals could be electric or electro-pneumatic, and track-circuiting could be readily installed throughout, thus adding additional safeguards.

Mr. R. T. Smith, M.I.E.E., chief electrical engineer, Great Western Railway, said that one of the great limitations of electric traction in this country was that in the 700,000 wagons owned privately, the drawing gear was not kept to the strength which the railway companies themselves maintained. If the drawing gear, not only of private but railway companies' wagons, was ever strengthened, then within any of the fifty odd British railway structure gauges, electric locomotives could still be built to haul the heaviest train which would be wanted in this country. He referred to trains of about 1500 tons. For most of the structure gauges the heaviest steam locomotive that could be built had already been provided. Even if the maximum size of steam locomotive had not already been reached on most of the railways, the heaviest locomotive axle load which could be carried by the bridges, had been reached in the steam locomotive, because no increased power in steam locomotives could be obtained without increased weight. The axle loads of electric locomotives was materially less, partly because there was no boiler, but also because all the axles, if they liked, could be made power axles. Although on the Continent, and to some extent in America, designs for electric locomotives were used in which the rotary motion required by the wheels was obtained from the rotary motion of the electric motors through connecting rods and coupling rods, such designs seemed to be unnecessary in Great Britain. If the rotary motion of the wheels was obtained from the rotary motion of the electric motors through gearing, the balancing could be made nearly perfect, and the first cost of the electric locomotive was a minimum. The locomotive maintenance costs on the Newport and Shildon electrified lines of the North-Eastern Railway were a quarter of those of the corresponding steam locomotives which preceded the electrification, and on the Chicago, Milwaukee and St. Paul Railway they were one fifth. On the Newport and Shildon line—a mineral line—the electric locomotive train miles were just double the steam locomotive train miles, with the result that the same number of train miles

could be hauled by half, and less than half, the number of locomotives as were previously used for steam haulage. On the Norfolk and Western Railway in the United States, where coal trains of over 3000 tons were formerly hauled by 27 steam locomotives in one division, similar mineral trains were now hauled by seven electric locomotives. Again, in the electric locomotive the ratio of average speed to maximum speed was greater than in the steam locomotive, or, in other words, for the same average speed, the maximum speed of the electric locomotive was much less than the corresponding maximum speed of the steam locomotive. An electric locomotive having a maximum speed of 60 miles per hour could generally maintain an average speed 50 per cent. greater than the speed of the corresponding steam locomotive. As to the saving in cost of power by using electric locomotives instead of steam locomotives, careful comparisons on the Chicago, Milwaukee and St. Paul's Railway showed that 6½ lb. of coal in a steam locomotive, in 1915, was required to do the same work as 1 kilowatt of electricity in an electric locomotive in 1916. The saving amounted to nearly half the cost of the coal, and was available for the interset on the new capital.

Mr. J. A. Hookham, M.I. Mech. E., locomotive engineer, North Staffordshire Railway, remarked that although terminal working had been much improved by electrification, it did not appear that the best was attempted previously with steam, with the result that a great portion of the life of a steam locomotive was—from a revenue-earning point of view—wasted. It was claimed, too, that the electric locomotive required very little inspection and few light repairs—but the first cost was greater, and the life probably less than in the steam locomotive, for which thirty years was quite a reasonable average. Again, adding the cost of repairs to the machinery at the power stations and sub-stations, and the maintenance of the conductors, it was, to say the least, doubtful whether experience would show any saving on the maintenance side. The higher acceleration obtained with electric locomotives was of very small value on long runs, but the great reserve of power, and the capacity of the motors to work at a considerable overload for some time, enabled a greater speed to be attained on an up grade than with the steam locomotive, and thus increased the average speed. An objection raised against electrification was that a whole section might at any time be thrown out of use and the traffic stopped, but this had not proved a very real difficulty. One advantage of electrification was the possibility of using regenerative braking—saving power and brake blocks, a factor which varied in importance according to the contour of the line. The cost of brake blocks on a certain railway was to-day 2½ per cent. of the fuel bill, and part of this sum would be saved by regenerative braking. It was possible, he concluded, that further improvements in steam locomotives, or the development of the internal combustion engine, might alter the whole aspect of affairs before many years were past.

Mr. C. F. Bengough, M. Inst. C.E., chief engineer, North-Eastern Railway, said that in the electrification of a main line the aim would be to work all traffic, both passenger and goods, electrically, and it would, therefore, be necessary to electrify certain portions of the sidings of all stations and goods yards to enable engines to receive and deliver their loads. In the case of a line electrified on the third rail system, in order to make the sidings safe for shunters to work, the third rail would have to be very fully protected, and would form a very serious obstruction. Overhead equipment would, therefore, appear to be the only practical form to adopt where shunting had to be carried on. The disadvantages of the third rail were increased difficulty in maintaining the track, the third rail forming an obstruction to the packing of the sleepers. In cases of derailment on the third rail side, a comparatively slight displacement of a vehicle would wreck the third rail. At level crossings or at junctions it was not possible to have a continuous rail, and at such points it would be necessary to erect a short length of overhead equipment, or provide some other means of moving the train should the engine happen to stop on a gap. The main advantage of the third rail was its accessibility. Repairs could be carried out without the use of a special tower wagon. On the other hand, to carry out any repairs to the third rail the current had to be cut off. The overhead equipment was an obstruction to the working of breakdown cranes in the case of an accident, and heavy gales caused the contact wire to be blown off the engine bows. But the maintenance of the track was not interfered with, and could be carried out by the platelayers without any risk of accident. In the case of derailment a considerable displacement of a vehicle had to take place before it would foul the supports of the overhead equipment. In the electrification of the portion of the North-Eastern main line which was under consideration, it was proposed to employ a pressure of 1500 volts, and the best protected third rail. The balance of advantage, however, was, he thought, with overhead equipment. With a certain type of construction which he described he estimated that a line could be quite as cheaply equipped with overhead wires as with a third rail, and the maintenance costs showed a considerable balance in favour of the overhead.

Dr. F. C. Lea, M. Inst. C.E., M.I. Mech. E., said that the steam locomotive could not be increased in height or width, nor the boiler or cylinders made larger, while its weight and axle loads were limited by the cross girders of the bridges; 60 per cent. of the weight of the engine and tender was concentrated on a rigid wheel base of about 15ft., with a load of about 20 tons per axle. The weight of an electric locomotive, having the same tractive force, could be distributed over more axles; no bogie need exceed 8ft. 6in. long, and the "equivalent load per foot run," which determined the bending moment on the main girders, could be less; 75 per cent. of the weight of the electric locomotive could be on the driving axles, but only 60 per cent. of the weight in the case of steam locomotives and tenders. Portions of the weights of the reciprocating masses of the steam locomotive could not be balanced in a vertical direction, and at high speeds set up additional stresses in cross girders. There need not be any reciprocating masses in electric locomotives. The steam locomotive had reached the limit of its power without heavy expenditure on the bridges, but electric locomotives could provide higher tractive force, and handle heavier trains at better mean speeds over existing structures. Against the heavy capital expenditure necessary for conversion to electric traction there would be many assets, besides those arising from economy in fuel and wages.

Mr. R. A. Chattock, electrical engineer for the City of Birmingham, said that from the point of view of the electric power station a railway load was a valuable one, because it gave a high load factor. They were told it should approach 60 per cent. The ordinary load factor at power stations was in the neighbourhood of 30 to 33 per cent., so that if the railway load factor could be super-imposed upon the power station it would improve the results obtained in the station, and reduce the cost of current. That would be a benefit not only to the industrial supply from the station, but also to the railway supply itself. The fear had been expressed that it would not pay to electrify the main lines of railways. Electrification which had taken place so far on suburban lines had, they were told, attracted an increased amount of traffic. The only way in which it could attract additional traffic was by making the traffic cheaper or easier. It had done so on the suburban lines; why should not the same thing happen on the main railway lines?

Professor Burstall remarked that Mr. Burn had read a paper on January 6th before the North-East Coast Society of Engineers, in which he advocated combining a direct drive from a Diesel engine, with compressed air for providing the starting torque. It might be worth while investigating this plan before the country embarked on costly schemes for electrification.

Professor Cramp said that some speakers had taken it for granted that the traffic on the main lines was to be similar, under electrification schemes, to that which existed to-day. That to his mind was to start absolutely at the wrong end. The distances between large towns in England, say, Birmingham and London, were, after all, only suburban traffic distances, when viewed from the standpoint of railway and geographical conditions in the United States. If the conditions which suited suburban traffic when the suburban lines were electrified could be applied to what they called main lines in this country, the result would be a great increase in travelling. He was perfectly certain that there was an enormous demand for short trains of high acceleration and high frequency from places like Birmingham to London, Oxford to London, and so on. That was where the railway engineer should start in his electrification schemes if he wished to make the main lines of England a success. The present long train was an attribute of the steam locomotive; and if the railway engineer would start with all the advantages of electric traction, with shorter trains, high acceleration, and great frequency, he would make the thing a success from the outset. Having regard to foreign experience, some of them were dismayed at the decisions which had been arrived at by the Railway Commissioners with regard to the transmission and distribution of electric power. Direct current at 1500 volts might be a success, but this was not the time to lay down any hard-and-fast regulation. They should have far more elasticity and be allowed time for discussion before they were limited in that way.

Dr. Gisbert Kapp said that the point made by Dr. Lea was illustrated by experience in the alternating current electrical equipment of main line railways. It was essential that they should allow for three-phase locomotives; the engines weighed only 60 tons and developed 2000 horse-power. There was no steam locomotive that could come anywhere near such figures. He wished to emphasise the value of a system which had been developed in Switzerland. He referred to the single-phase alternating current of low periodicity. He was pleased to hear one speaker say that on the whole the overhead wire was preferable for several reasons, but with 1500 volts direct current they would not go far, nor would 3000 volts take them any distance, unless sub-stations were dotted all along the line. It was no use going in for half measures in that way. If they compared 3000 volts with 15,000 volts on an overhead wire they would find that the diameter of the wire need only be half, with one-fourth the area and the sub-stations could be ten times as far apart. In conclusion, he expressed the hope that whatever system was adopted, it would only be chosen after very careful consideration, because once they had adopted a system they could not change it. Moreover, they could not contemplate the possibility of every railway having its own different system. They might have different details. He would not advocate for one moment that they should stereotype any detail, for that would kill the possibility of improvement. But what they could make uniform was the main principle, and that was low periodicity, high voltage and single phase.

The Chairman, in summing up the discussion, said that the consideration they wanted to keep in view was the answer to the question:—Is it going to pay us to electrify our main lines? Professor Cramp suggested that they might run smaller train units. He did not see much hope from that procedure. On the heavy train to-day they had a driver, fireman, and guard. They would have to have a driver and guard on the shortest trains. Labour entered into the running of trains just as it did into the running of power stations. Neither did he look upon the Diesel locomotive as a competitor with electrified main lines, save perhaps in exceptional circumstances, such as with low density of traffic. There was no insuperable electrical or mechanical difficulty in the electrification of main lines, but there was a difficulty with regard to the financial side of the problem when they were dealing with traffic of low density. Round about a large town they had a high density of traffic, and the interest on the new electrical equipment was practically nothing. The maintenance figures had to be looked after, but the maintenance cost in suburban areas was not proportional per ton mile to what it was when they were running through a large area of country with a small amount of traffic on the line. The difficulties were more mechanical than electrical. The electrical side of the problem seemed to be perfectly sound. There were certain mechancial difficulties. One of them, unfortunately, had not been touched upon, namely, the question of low centre of gravity and wheel arrangement.

BOOKS RECEIVED.

Architectural Office Administration. By Francis Lorne. London: Technical Journals, Limited, Westminster.

The Adjustment and Testing of Telescope Objectives. York: T. Cooke and Sons, Limited, Buckingham Works.

Oils, Fats and Fuels. By T. Hull. London: Blackie and Son, Limited, 50, Old Bailey, E.C. 4. Price 3s. 6d. net.

The Book of the Ford Van. By R. T. Nicholson. London: Temple Press, Limited, 7–15, Rosebery-avenue, E.C. 1. Price 3s. net.

The Westinghouse Air Brake. London: The Locomotive Publishing Company, Limited, 3, Amen-corner, E.C. 4. Price 2s. 6d. net.

The Lubrication of Locomotives. By E. L. Ahrons. London: The Locomotive Publishing Company, 3, Amen-corner, E.C. 4. Price 5s. net.

The Origin of Modern Calculating Machines. By J. A. V. Turck. London: H. E. Robbins, Limited, Imperia House, 15–17, Kingsway, W.C. 2.

Hydraulics of Pipe Lines. By W. F. Durand. London: Constable and Co., Limited, 10–12, Orange-street, Leicester-square, W.C. 2. Price 18s. net.

The Designers of Our Buildings. By L. Cope Cornford. London: Royal Institute of British Architects, 9, Conduit-street, Hanover-square, W. 1. Price 5s. net.

Electric Clocks and Chimes. A practical hand-book on their design and construction. London: Percival Marshall and Co., 66, Farringdon-street, E.C. 4. Price 3s. 6d. net.

Oil Shales. By H. B. Cronshaw. Monographs on mineral resources with special reference to the British Empire. London: John Murray, Albemarle-street, W. 1. Price 5s. net.

Foreign Exchanges and How to Profit by Them. By V. E. Gerard. London: Pall Mall Industrial Investments, Limited, Trafalgar House, Waterloo-place, S.W. 1. Price 1s. net.

The Model Engineer Series No. 43: Hardening and Tempering Engineers' Tools. By George Gentry. London: Percival Marshall and Co., 66, Farringdon-street, E.C. 4. Price 9d. net.

Power's Practical Refrigeration. Compiled by the Editorial Staff of *Power*. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 10s. net.

Costing for Manufacturers. By W. Howard Hazell. With a foreward by the Rt. Hon. Lord Leverhulme. London: Nisbet and Co., Limited, 22, Berners-street, W. 1. Price 12s. 6d. net.

The Rights of the Ex-Service Man and Woman. By W. Sherran. With an introduction by the Rt. Hon. Charles A. McCurdy, K.C. London: L. J. Gooding, 25, Old Queen-street, Westminster, S.W. 1. Price 6d.

Waste in Industry. By the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 20s. net.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 4: The Theory and Practice of Acid Mixing. London: His Majesty's Stationery Office. Price 12s. net.

Tug with Grain Ship Discharging Plant.

IN order to meet the peculiar conditions which have to be fulfilled in connection with the discharging of grain ships at the port of Limerick, on the river Shannon, an interesting and novel vessel has recently been acquired by the flour milling firm of J. Bannatyne and Sons, Limited. The vessel—the Garryowen—is a combined tug and grain ship discharging plant, the hull of which was designed by Messrs. McKie and Baxter to meet the requirements of Henry Simon, Limited, Manchester, who were the main contractors, the vessel being built by Messrs. George Brown and Co., Greenock. The depth of water over the sill at the Limerick dock at high water varies between 16ft. and 22ft. 6in., and the nearest point at which vessels of any size can lie afloat at all states of the tide is off Beigh Castle, about 18 miles down the river, and there, large ships carrying heavy grain cargoes have to be lightened before proceeding to dock. When a deeply laden grain ship arrives in the river, the Garryowen tows down the river a capacious lighter capable of holding about 1600 tons of grain. The tug is tied up alongside the steamer with the lighter on her free side, and as much grain is discharged by the pneumatic plant into the lighter as is necessary to enable the steamer to clear the dock sill and complete the discharging operations. The Garryowen then tows the lighter—and on occasions a sailing vessel as well—to Limerick, where, by means of the pneumatic plant, the remaining grain is discharged on to band conveyors running in a subway along the quay, which, in their turn, transport the grain direct to Messrs. Bannatyne's warehouses.

Off Beigh Castle the Shannon estuary is of considerable width, and the water is liable to be very rough. In order to enable the grain to be removed from the ship to the lighter, special means of conveyance had to be provided which would operate effectively when the various vessels were all rolling together. For the purpose Messrs. Simon devised means for blowing the grain into the lighter by flexible pipes, no more rigid connection being practicable under the circumstances. Incidentally, this blowing arrangement also obviates the hand labour required for "trimming" the grain on those occasions when the lighter has to be filled to its utmost capacity. The pneumatic plant installed was designed to deal with 150 tons of wheat per hour by means of a suction plant and 120 tons per hour by suction and blowing combined—capacities which have been considerably exceeded in actual working conditions.

In addition to these special duties when dealing with grain cargoes, the Garryowen will act as a tug for general traffic on the Shannon, and in this connection she may be required to proceed 50 or 60 miles down the estuary or even go to sea for considerable distances. Under such circumstances it was necessary that she should be designed on sea-going lines. As a matter of fact, she did steam from the Clyde to Limerick without any part of her equipment being dismantled.

As being of historical interest, it may be stated that the Garryowen is now superseding an old combined tug and pneumatic grain-handling plant which bears the same name, and which was designed twenty-five years ago by the late Mr. F. E. Duckham, who was the inventor of the pneumatic grain-handling system. It may be of interest, also, to record that the hull of the old Garryowen was that of the Saxon, which was the first steamship to sail to the Cape of Good Hope sixty-seven years ago.

FIG. 1—THE GRAIN-SHIP DISCHARGING TUG GARRYOWEN

The new vessel, of which we give a general view in Fig 1, is 160ft. long between perpendiculars, has a 26ft. moulded beam, a 17ft. moulded depth, and a draught of 13ft. aft and 12ft. 6in. forward. She is fitted with a keel of the bar type, and is built with a flush deck, provided with bulwarks fore and aft. As she is required to work between the ship and the quay wall, she has four specially deep web frames, and the sheerstrake plating for about three-fifths of her length is also specially heavy. Three water-tight bulkheads are arranged at the fore and after ends and amidships. The bulkhead amidships is recessed to form side pockets and a water-tight tunnel runs between this bulkhead and the fore end of the boiler-room, where a water-tight door is fitted, so that under ordinary conditions there is free communication between the engine-room and the forward machinery space containing the grain-handling plant. Aft of the amidship section the vessel resembles an ordinary tug. The main engine is of the triple-expansion type, designed to develop 950 horse-power, and was built by Messrs. McKie and Baxter, Govan. A high-speed steam generating set is provided for the electric lighting of the ship. The tug was designed for a maximum speed of 11¼ knots, which was easily attained during her trials. There are two marine boilers, each 10ft. diameter by 11ft. long, and the furnaces are fitted with a Howden forced draught installation. The bridge wheel-house is situated forward of the grain-handling machinery. Four cabins and a mess room are provided for the ship's officers, and there is sufficient crew space forward to accommodate twelve men.

On page 107 and herewith we give a series of drawings of the vessel and her equipment. Fig. 2 is a longitudinal section, Fig. 3 a plan of the pneumatic plant, while Figs. 4 to 6 inclusive show various details of that plant. The general arrangement of the grain plant can best be understood by referring to Fig. 2 and to the drawings on page 107, from which it will be seen that the receiver and pipe handling gear are mounted on the deck of the vessel, practically amidships. The grain is drawn from the cargo steamer by means of pipes, described later, and is deposited in the receiver G 1—page 107—in the centre of the structure, whence it flows into the tipper seal A—Fig. 3 and page 107. This seal, which is of Messrs. Simon's well-known type, is situated immediately below the deck, and it delivers the grain into a steel hopper B, which is furnished with a shoot that feeds a chain type bucket elevator C, the boot of which stands on the floor of the vessel. Forward of the receiver and immediately abaft the bridge there is a deck-house containing two "Avery" 1-ton automatic grain-weighing machines D, supported in pendulum frames E. These weighers, which are fed by the elevator just mentioned, discharge the grain into a receiving hopper F, which has three alternative outlets. The first delivery is obtained by means of a second bucket elevator G, which is provided with a swivelling, hinged and telescopic discharge spout H, supported by a light steel crane jib J. By this means the grain is fed overside on to the band conveyors which run in a subway below the quay at the point where the bulk of the grain is discharged. An alternative delivery is to a rotary seal K—Fig. 3—which admits the grain into pipes L—Fig. 3 and page 107, through which the vacuum pumps can be arranged to exhaust. By this arrangement grain can be blown over-

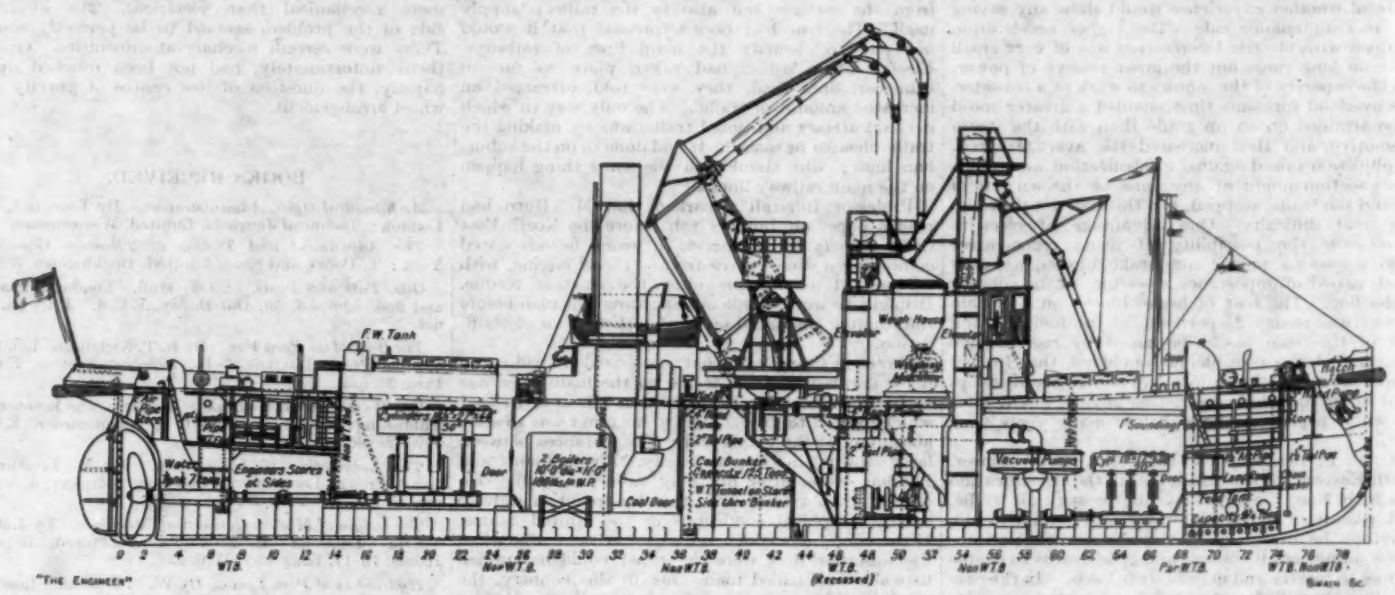


FIG. 2—LONGITUDINAL SECTION OF THE GARRYOWEN

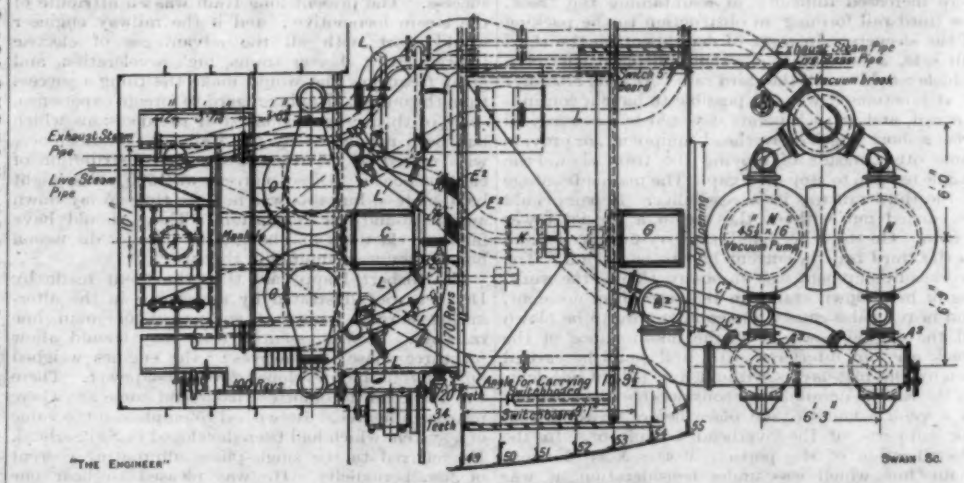
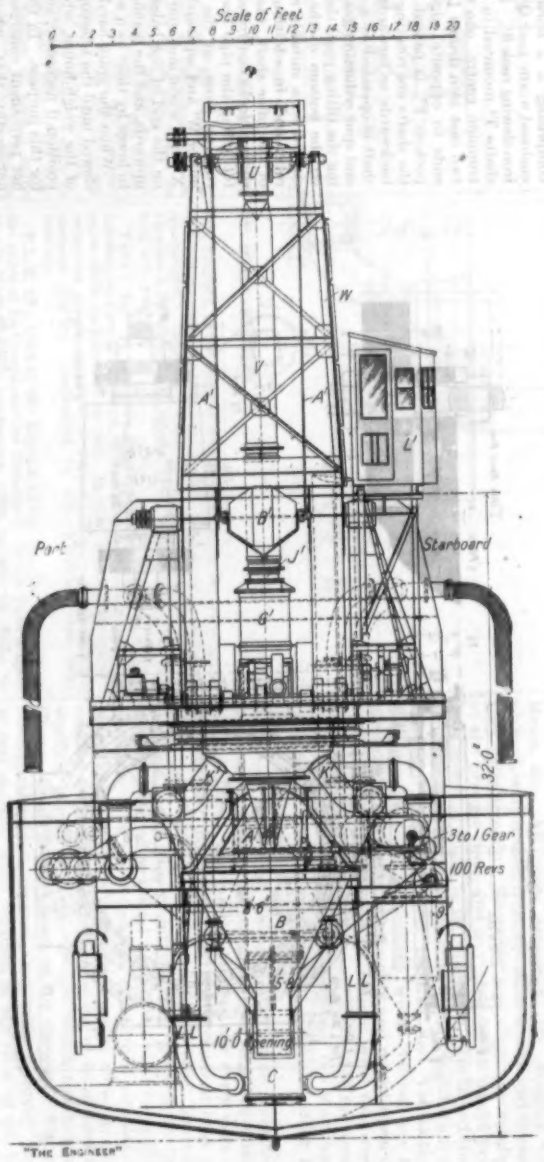


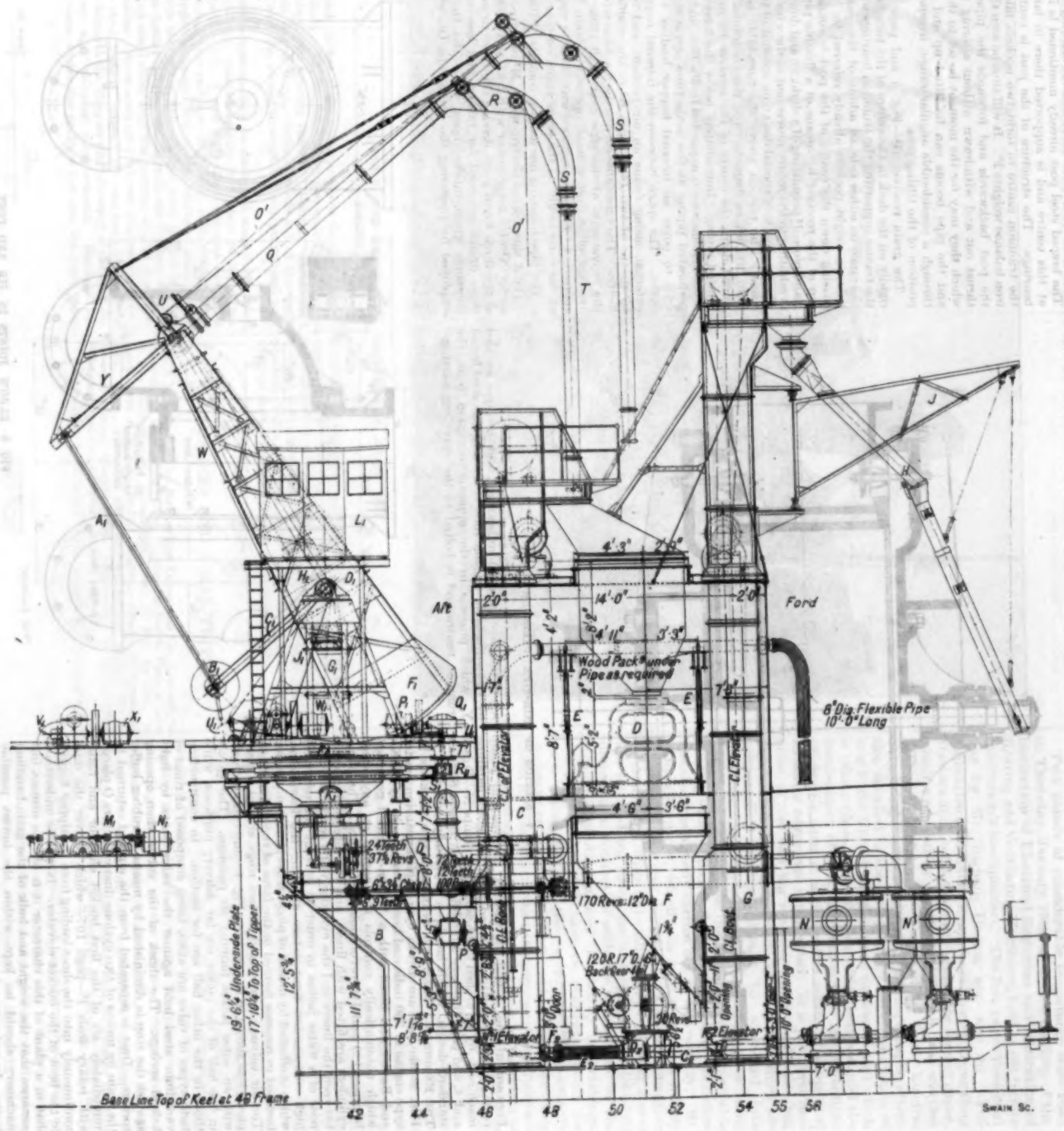
FIG. 3—PLAN OF PNEUMATIC PLANT

THE GRAIN-HANDLING EQUIPMENT OF THE GARRYOWEN

HENRY SIMON, LIMITED, MANCHESTER, ENGINEERS

(*For description see opposite page*)




Aft
Fore
Ford
Wood Packs under Pipe as required
8" Dia. Flexible Pipe 10'0" Long
170 Revs. 12" Dia.
120 R. 17" Dia. Gear
Base Line Top of Keel at 48 Frame
42 44 46 48 50 52 54 55 58
SWAIN Sc.

side into the lighter. The third alternative delivery consists of a spout arranged so that the contents of the hopper F can be drawn off into sacks and weighed to check the accuracy of the weighing machines from time to time.

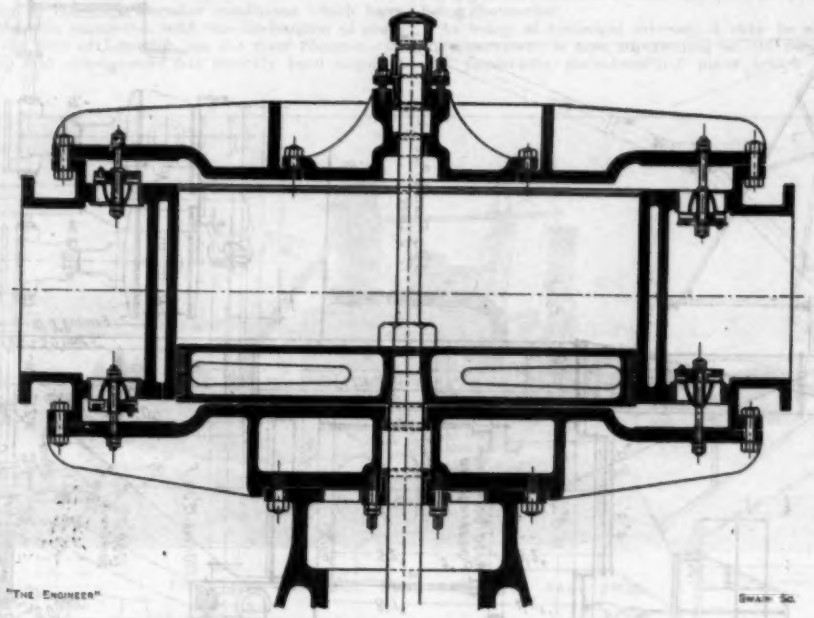


FIG. 4—SECTION OF AIR-PIPE CYLINDER

Forward of the second elevator is the vacuum pump room, which is partly separated from the grain-handling machinery by an arched bulkhead. The pumps N—Figs. 3 and 4, and page 107—are a modification of Messrs. Simon's standard design, which has been previously described in THE ENGINEER. They have cylinders 45½in. diameter by 16in. stroke, and are driven by a triple-expansion marine type engine of 350 indicated horse-power, built by McKie and Baxter and fitted with a Wilson-Hartnell governor, which automatically controls the engine at any speed between 120 and 140 revolutions per minute. The pump cylinders are fitted with liners, and the intervening space between the liners and the cylinder walls serves the purpose of a water jacket in order to prevent the relatively high compression temperature affecting the lubrication, which is effected by means of plugs of graphite composition inserted in recesses formed in the faces of the piston rings. The air valves are arranged in two rings around a periphery—as shown in the drawing Fig. 4—and communicate with an outer jacket forming air passages. The valves in one half of the jacket are for delivery purposes, while those in the other half are for suction. In construction both types of valve are alike, being composed of rings of vanadium steel held against the valve seats by light helical springs. The shock of the valve when opening against the stop is diminished by means of rubber buffer springs. Dust is separated from the air and returned to the grain by means of two cyclone dust collectors O placed immediately aft of the first bucket elevator and fitted with rotary seals P—page 107—which deliver the dust continuously into the shoot leading from the tipper hopper to the boot of the bucket elevator. It will be understood that in a plant of this character it is of the utmost importance that the weight and bulk of the grain-handling machinery should be kept within the lowest possible limits. In order to achieve that object, and at the same time to provide for the mechanical manipulation of the suction pipes over the widest possible range, a type of pipe handling gear, patented some years ago by the late Mr. A. H. Mitchell (of the Port of London Authority) has here been adopted for the first time. There are two pipe booms or arms Q fitted in the usual way with bends R of rectangular section and provided with renewable wearing plates. From the end of these booms depend flexible piping S with telescopic sections T and a suction nozzle. The booms are connected at their inner end by means of a double cast iron swivel joint U—Fig. 6—to a single down pipe V which passes through the centre of the braced steel post W. The swivel castings are supported at the top of this post in trunnion bearings, and the pipes are tied by two adjustable tension rods to a triangular steel frame Y, which projects in the opposite direction from the trunnion centre and is bolted to the swivelling castings.

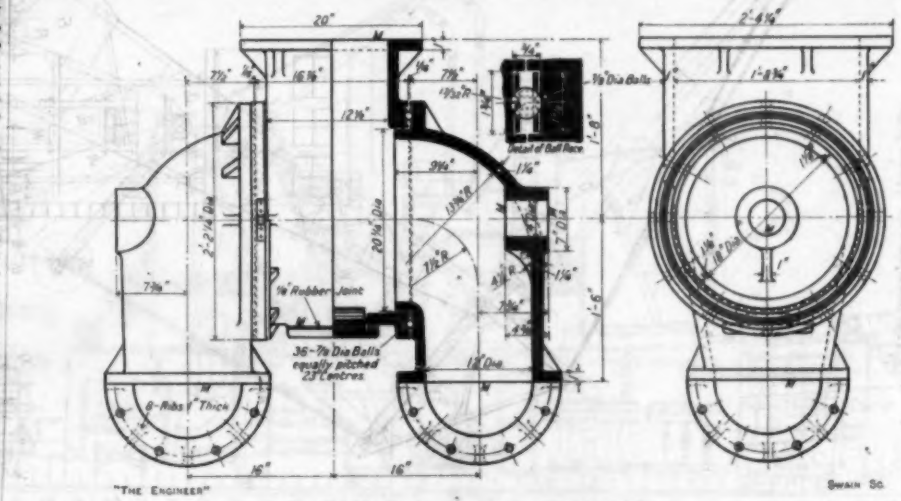


FIG. 6—ELBOW JOINTS IN JIB AND POST

Two steel links A^1 connect the outer extremity of the triangular frame with a cast iron balance weight B^1 which is carried by a radial arm C^1 swinging about a lower trunnion centre D^1 to be presently described. The post, triangular frame, links and balance weight arm thus form a parallel motion by means of which the pipe booms are balanced by the weight B^1, which is arranged very much lower than they are themselves. The lower trunnion bearings are carried by steel frames mounted on a revolving table E^1—page 107. This table—see Fig. 5—is provided with conical cast steel roller tracks of the crane type, and the lower trunnion centre is arranged at a height of 13ft. 9in. above the deck, whereas the roller centres are only 3ft. above it. The braced steel post already mentioned is itself pivoted at this centre and is supported there in large cast iron bearings. The structure of the post is continued below the trunnion centre to form two pockets filled with cast iron balance weights F^1. It will thus be seen that by tilting the post backwards and forwards the pipe booms are thrust out and withdrawn without altering the angle at which they may for the moment be set to the horizontal, and the pipe booms can be lifted up and down freely through a considerable angular range, irrespective of the position of the tilting post.

The grain receiver G^1—Fig. 8 and page 107—stands rigidly on the deck in the centre of the turn-table between the frames supporting the trunnion bearings with sufficient clearance on either side to admit of the passage of the balance weight pockets already referred to. The pipe V passing down the centre of the post is connected to the top of the receiver by means of a flexible pipe H^1 and a gland piece J^1 permitting of a slight up and down movement in addition to the rotary movement of the whole apparatus. The receiver is of special design on account of the restricted space. The portion above the turn-table is tubular in form 2ft. 6in. in diameter, and the grain inlet pipe is continued down the centre of the receiver by means of perforated piping. Immediately below the level of the turn-table the diameter is expanded to 6ft. 6in., and the internal perforated piping at the same time opens out umbrella-wise to cover an internal hopper leading to the grain outlet. The space between the internal hopper and the external casing forms an air passage, and is connected by means of two 14in. pipes K^1 to the cyclone dust collectors. The turn-table carries the machinery for operating the movements of the pipe gear. All these movements are controlled from a small operator's cabin L^1, which is supported by steel stanchions with its floor approximately at the same height as the lower trunnion bearings.

The pipe handling mechanism consists of the following:

(1) A three-drum electric winch M^1 operated by a single motor N^1 of 5 horse-power with friction clutches for each of the three worm gears driving the three drums. Two of these drums are used for raising and lowering the two telescopic grain intake pipes, while the third drum is employed for operating the crane rope O^1, which passes over a pulley at the head of the pipe boomd is use and for hoisting additional flexible pipes, &c., in and out of the grain vessel. Considerable ingenuity has been shown in arranging the leads of the ropes from the winch drums to the telescopic piping and the crane sheave. (2) Slewing gear comprising a 5 horse-power motor P^1 with horizontal enclosed worm gear Q^1 and pinion R^{11} working in a cast iron slewing rack S^1. (3) Post tilting gear, comprising two shafts T^1 mounted in bearings and placed parallel to the trunnion centre, one on either side. Each shaft carries two cast iron drums U^1, and a wire rope, attached at its ends to opposite edges of each of the balance weight pockets F^1, is passed around these drums, so that when the shafts are rotating the lower end of the post is hauled backwards or forwards as the case may be. The driving shaft is operated by a 5 horse-power motor through worm and spur reduction gear. When this mechanism is operating the tilting post, the rope naturally wraps and unwraps on the bottom of the balance weight pockets, which is curved to a suitable radius to take up the slack of the rope, and, in addition, the rope is kept taut by means of the idler shaft, the bearings of which are carried in sliding blocks controlled by compression springs. (4) Gear for luffing the pipe booms consisting of a winch drum V^1 running loose on the driving shaft of the post tilting motor W^1 and separately driven by a 3 horse-power motor X^1 with worm and spur reduction. This winch drum hauls on the end of the balance weight arm C^1 to luff the pipes upwards, and the booms are just sufficiently out of balance to lower by their own weight when the rope is slackened.

When the grain-handling gear is not in use, the table is slewed until the telescopic pipes come up against the sides of the weigh-house, where they can be quickly lashed in position if necessary, suitable attachments being provided for this purpose. In this position the vessel is in trim by her permanent concrete ballast of about 130 tons. It is noteworthy that, when the tilting post leans outboard to give the pipes their maximum reach of 36ft. from the centre of the vessel, the list is hardly appreciable.

The controllers for the four electric motors operating the pipe-handling gear are of the tramway type, enclosed in two casings, and are situated in the control cabin where also are three levers attached by wires to the three clutch levers of the multiple winch.

On the port side of the grain-handling compartment

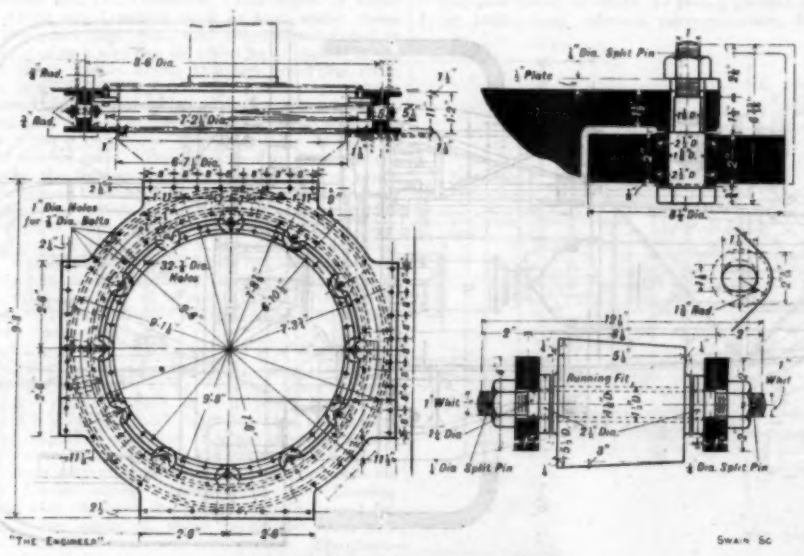


FIG. 5—DETAILS OF REVOLVING TABLE

there is a 70-kilowatt high-speed generating set, which supplies electricity for driving the tippers and seals, the two bucket elevators, the four motors operating the pipe handling gear, and for supplying electricity to a motor

FIG. 7—THE GARRYOWEN UNLOADING A GRAIN SHIP

ashore which drives the band conveyors in the subway below the quay. The lighting circuit can be fed either from this 70-kilowatt set or from the ship's lighting set situated in the main engine-room. Switchboards are of the iron-clad type, and the wiring throughout is in galvanised iron conduit.

The blowing system may be described more fully since it is a somewhat unusual feature in a plant of this kind. The pumps N—Fig. 3 and page 107—exhaust into two circular tanks or air receivers A^1 having 16in. sluice valves at their upper ends and 8in. sluice valves at their lower ends. From the upper valves sheet steel piping leads to an exhaust funnel B^1 placed alongside the forward bucket elevator and used when only the suction side of the plant is in operation. From each of the lower 8in. valves, pipes C^1 lead to the injection "piece" D^2—see page 107. These pipes pass beneath the chequer plate flooring of the vacuum pump room and elevator compartment. Beyond the injection piece, where the grain is fed into the pipes from

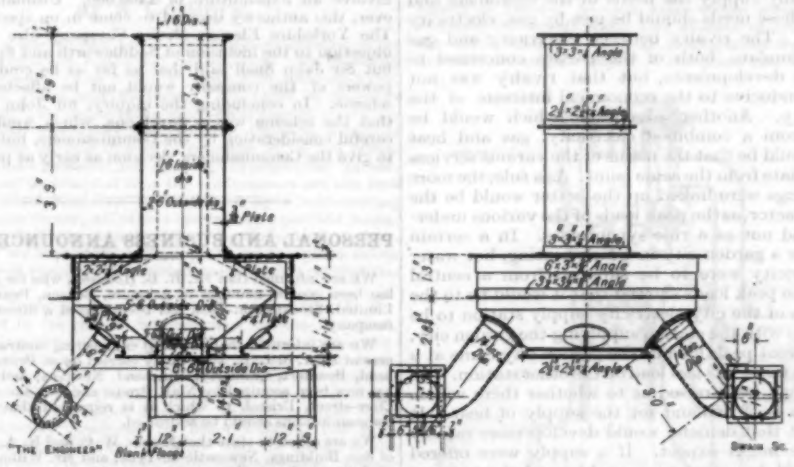


FIG 8—ARRANGEMENT OF GRAIN RECEIVER

the rotary seal, each pipe is continued by means of a flexible piece E^1, the end of which is provided with a quick-coupling flange F^1, enabling it to be connected to either of the two fixed lengths of delivery piping L, which are arranged on the port and starboard sides of the vessel, and which pass up into the weigh room and out through the sides of the weigh-house casing. Thus by swinging these flexible pieces—which rest on the bottom of the boat—from one side to the other and re-coupling, delivery may be transferred from the port to the starboard side of the ship or vice versâ. Where the fixed ranges of piping come through the weigh-house casing, quick-coupling flanges are provided for the attachment of portable lengths of flexible piping leading to any part of the lighter, and light derricks are supplied for supporting these flexibles.

As the total length of the two ranges of blowing pipes with their portable flexible extensions may be quite different, and as the air pressure necessary for their operation may not be equal in each pipe, the rotary seal and the injection piece are divided by a central diaphragm, so that each vacuum pump cylinder is connected with its own blowing pipe. The blowing seal closely resembles the ordinary rotary seal for suction conveying plants installed by continental and some other makers, except that special provision is made for sealing the circumferential joint by means of a leather ring which is pressed outwards by pressure against an exterior steel ring. The seal is belt-driven, with an arrangement of fast and loose pulleys from countershafting which also drives the small rotary seals on the cyclone dust collectors and the main tipper seal.

LAUNCHES AND TRIAL TRIPS.

P.L.M. 25; built by Sir Raylton Dixon and Co., Limited, to the order of La Compagnie des Chemins de Fer de Paris à Lyon et a la Méditerranée; dimensions, 400ft. by 50ft. by 31ft.; to carry 8900 tons deadweight. Engines, quadruple-expansion, 23in., 32½in., 47in., and 68in. by 48in. stroke, pressure 220 lb.; Howden's forced draught fitted; constructed by Richardsons, Westgarth and Co., Limited; launch, recently.

VINDEGGEN; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of Jens Folkmans Rederi, Kristiania; dimensions, 330ft. by 46ft. 10in. by 28ft. 6in.; to carry 5000 tons deadweight. Engines, triple-expansion, pressure 180 lb.; Howden's forced draught fitted; constructed by the builders; trial trip, recently.

TANA; built by Palmer's Shipbuilding and Iron Company, Limited, to the order of Wilh. Wilhelmsen, of Tonsberg; dimensions, 380ft. by 52ft. 3in. by 28ft. Engines, single-screw double-reduction geared turbines of Parsons impulse reaction type, pressure 200 lb.; constructed by the builders; trial trip, recently.

P.L.M. 23; built by Sir Raylton Dixon and Co., Limited, to the order of La Compagnie des Chemins de Fer de Paris à Lyon et a la Méditerranée; dimensions, 400ft. by 50ft. by 31ft.; to carry 8900 tons; trial trip, November 14th.

POITIERS; for coal-carrying traffic; built by Tyne Iron Shipbuilding Company, Limited, to the order of Paris-Orleans Railway Company; dimensions, 378ft. by 53ft. by 26ft.; to carry 7000 tons deadweight. Engines, triple-expansion, 23½in., 38in., and 64in. by 42in. stroke, pressure 180 lb.; constructed by Sir W. G. Armstrong, Whitworth and Co., Limited; trial trip, November 16th.

The Utilisation of Exhaust Steam.

Two papers of considerable importance were read on Thursday, January 19th, at a joint meeting of the Institution of Electrical Engineers and Institution of Heating and Ventilating Engineers, held at the former Institution's headquarters. The first paper presented was by Mr. Ingham Haden, and was on "The Utilisation of Exhaust Steam from Electric Generating Stations and Coal Economy," whilst the second paper, which was read by Mr. F. N. Whysall, was entitled "The Utilisation of Waste Heat from Electric Generating Stations." In Mr. Haden's paper attention is called in the first place to the consumption of coal in the United Kingdom and the loss of heat which is taking place in electric generating stations, and the combination of heat distribution with the generation of electric current as a possible means of using coal to better advantage is suggested. It is proposed that some of the existing stations which would be shut down under the super-station scheme, and which are conveniently situated, should be converted into heat distribution stations. The paper gives some particulars of a typical district showing the probable heating and lighting loads, and finally describes installations already carried out in this country. Mr. Whysall's paper, which is a very short one, merely suggests points for discussion. Several difficulties in connection with the utilisation of exhaust steam are referred to, such, for instance, as the financial difficulty in connection with the expenditure on the steam-distributing mains. Electricity undertakings, the paper points out, have no borrowing power for such a purpose, and the expenditure is necessarily a charge on revenue account, and in the most likely areas for a supply for heating purposes the streets are so congested with gas and water mains, sewers and electric cables, that it is a difficult matter to find room for steam mains, which must be designed on special lines in order to prevent excessive radiation losses.

Colonel Crompton, who opened the discussion, emphasised the fact that no system of heat distribution was the best under all conditions. If it were possible to find wayleaves for the pipes a case might be made for steam and hot-water heating. There had, however, been a great increase in the use of electric heating pure and simple. The convenience factor had in many cases outweighed the efficiency factor. The saving in labour which resulted from the use of electric heaters and the general adaptability of the system were advantages which could not be ignored. It was true that the system only had an efficiency of 4 or 5 per cent., but the efficiency of the heater itself was high. Heat could be obtained exactly where it was wanted, as, for example, at the sick man's bedside, and there was no loss on account of long periods of warming up. The British public would not, he felt sure, pay the present price for heating current if it was not to their advantage to do so. The saving of labour, &c., and the elimination of losses on the consumer's premises would enable it to supplement steam and hot-water heating. There was not one method of heating, but various methods.

Mr. F. Bigging said that high thermal efficiency was the main object to be aimed at, and the question under consideration was the utilisation of exhaust steam. There was no doubt, he thought, that this might be done in many cases with advantage. As an example of a successful steam-heating system in London, the speaker cited the plant at the Imperial College of Science, from which the exhaust steam is led into all the similar buildings in the vicinity, such as the Royal College of Science, the School of Mines, &c. All those buildings, Mr. Bigging explained, were heated from the same source and heated very satisfactorily. Economy was what was wanted at the present time, and anything which would produce economy ought to be considered. He hoped that as a result of the joint meeting of the Institution of Electrical Engineers and Heating and Ventilating Engineers a joint committee would be set up to investigate the matter thoroughly and report upon it.

Mr. W. H. Patchell dealt mainly with the work that had been done at Detroit, and exhibited some interesting lantern slides showing how the hot-water pipes were run in tunnels and covered in order to reduce radiation losses.

Mr. A. H. Barker thought that there were few subjects of greater importance than the one under consideration. He noticed that in the early part of his paper Mr. Haden had said that "without heat we could not exist," but that was, perhaps, scarcely accurate, as in this country it was possible to live entirely without artificial heat if we were compelled to do so. The use of heat by the general population varied very greatly. At the present time he was making experiments on the amount of heat used by working people in three cottages which the London County Council had placed at his disposal. Figures already obtained showed that with ordinary care 80,000 thermal units supplied in the form of gas per day would meet the requirements of a complete house composed of four or five rooms and occupied by two working-class people during cold weather. Taking that amount as an average daily consumption, 29,200,000 thermal units would be required per annum, and at a shilling per therm a cottage could be supplied

with gas throughout the year for £10 or £12. Tests carried out in the laboratory, however, had shown that the cost of solid fuel was about half that of gas. There was no doubt that a sum of £6 per annum would cover the cost of all the heating necessary in a cottage and without undue restrictions. Did anyone suppose, however, that it would be possible to heat a building of this sort from a central heating system at a cost of £6 per annum? There was the interest and depreciation on the capital outlay, maintenance, supervision and multitudinous other things that would enter into the cost. Moreover, would the working man take his heat in the form suggested? How was his wife to do her cooking? The British working man would insist on his coal fire or gas fire. It would be necessary to have gas as well as steam and electrical mains, and how were they going to be provided on £6 a year? What were the subways, pipe coatings, steam traps, pumps, and heaters going to cost? Did anyone imagine that a plant could be put down to serve, say, 1000 cottages for less than £100,000. In conclusion, the speaker urged that electrical engineers should devote all their energies and wits to an unremitting endeavour to reduce the waste involved in generating electricity. The only solution he could see to a scheme of centralisation was for the electrical engineer, the gas engineer, the mechanical engineer, the physicist and the heating engineer to combine in an effort to devise some method of generating electricity more economically. The gas people could put into their mains 80 per cent. of the energy in the coal, but at the same time they had to make gas so expensive that the working man could not really afford to use it. If the electrical engineer could get anywhere near that 80 per cent. efficiency electricity would be used universally for heat, light and power.

Mr. J. F. Ruggett contended that if a supply of heat could be provided cheaply artificial heating would be more widely used. Householders, he said, would no doubt adopt the practice of heating their bedrooms, which in the winter were as a rule very cold. The turbine, however, was essentially a condensing unit, and was not suitable for running non-condensing unless specially designed to work in that way. In view, however, of what had already been accomplished, there was no real difficulty in the direction of combining central lighting and power plants with heating plants. The great waste which was at present going on in connection with electric lighting and power stations could not be allowed to continue.

Mr. W. M. Selvey, who, as is well known, is the author of a pamphlet on combined hot water and electric power stations, referred, among other things, to a station heat balance diagram which had been exhibited by Mr. Whysall. That diagram, he said, showed a thermal efficiency of 10 per cent., but that was by no means the ideal value at which electrical engineers were aiming. The object of the super power station was to increase that value to 20 per cent., and even that was not the limit. A station was already in sight which would realise 25 per cent., and if the mercury vapour turbine proved successful, 30 per cent. might be realised.

Mr. W. W. Nobbs hoped that other joint meetings would be held with a view to discussing the subject under consideration. A big business in connection with district heating had been done in America. The first plant, which served some three miles of streets, was put into commission over forty years ago, and at the present time there were some 350 district heating companies, which comprised one of the most important industries in the United States. It was somewhat surprising that the competent electrical authorities who deplored the low efficiency of their stations had not investigated the possibilities of the heating business, which might provide a greatly increased overall efficiency and a regular source of income. He could not agree with Mr. Whysall's suggestion that with coal at 10s. per ton steam could be supplied at a cost of 10d. per 1000 lb. It could not be too strongly emphasised that thorough analysis of the capital and running costs should be made before fixing a tariff. The great difficulties which the American companies were now experiencing were due to the fact that too low a tariff was fixed in the first instance. The early tariffs were fixed by the commissioners when very little was known about the economic life of plant and mains. Again, many boiler plants having a test efficiency approaching 80 per cent. proved to have an overall efficiency of only 50 per cent. when banked fires and other losses were taken into account all the year round. The prime consideration in determining the price for heating steam was the market value, or what it would fetch. Electricity had displaced oil lamps for lighting, although the latter were less costly, and in the same way one might logically expect that users of heat derived from a central source would be willing to pay for the convenience, or saving of the trouble inseparable from independent apparatus in each building. A recent American bulletin gave the heating tariffs for the year 1921–1922 for the different companies spread all over the United States. Where steam was the source of heat, most of the companies had a sliding scale, the price dropping as the rate of steam consumption increased. The price varied in different parts of the country from approximately 1.5 dols. to .75 dols. per 1000 lb. for the first 10,000 lb. of steam condensed per month. There was usually a fixed charge of about 2.5 dols. per month for the meter and the service connection, and that charge represented the interest on the capital value of the meter, maintenance and repairs and the meter man's wages. Where a forced hot-water circulating system was adopted it was usual to base the charges either on a seasonal flat rate per square foot of heating surface installed, or on the estimated heat loss of the building as calculated by a standard set of heat loss coefficients, but the tendency even with hot-water systems was towards the more precise method of metering. The flat rate scale of charges for 1921–22 varied in different parts of the States from 65 cents to 40 cents per square foot of hot-water radiation, while steam radiation was estimated at approximately 25 per cent. more. The cost of coal was a very important factor in determining the cost of supply, but it was not the only factor. In addition to the coal bill, there was the cost of water and labour, the interest on capital, taxes and insurance, depreciation, maintenance, overhead and distribution costs. It would be wrong, therefore, to fix a scale which increased the charge in direct proportion to the cost of fuel.

Mr. J. F. Driver considered that in view of the fact that heat lost involved waste of money, electrical engineers should endeavour to sell their exhaust steam. What had been done in one place could be done in another. The question of the cost of steam heating in houses was always brought forward when that matter was discussed, but the present cost of hot water also had to be considered. Manufacturing companies, such as paper makers and dyers, could, with a properly laid out steam and electrical plant, compete with any supply company. A scheme had been prepared for heating the Loughborough College workshops, where there was a large number of students, and it would, when put into operation, result in a saving of £4700 a year. There was no doubt that it would pay many concerns to generate their own electricity and provide their own heat. The supply of heat to shops was a matter which seemed to present possibilities for the electricity supply undertakings. Mains might be run through the basements, and there was little doubt that there were many business firms that would be only too glad to take the heat supplied in this way if it were offered to them.

Mr. W. Nelson Haden considered that the ideal central municipal station would be one combining the generation of electricity, gas and heat and working with a destructor plant, so that all the municipal services might be concentrated at a suitable spot. The whole of the fuel might then be carbonised before it was used, and the by-products so obtained. In one fairly large town there was a tramway system which was run entirely by means of a destructor plant during certain hours of the day, and in another small town the day load of a lighting station was run in the same way. In another instance the hot-water supply for 580 houses was to be provided by a dust destructor. There was little doubt, the speaker thought, that the full value of the dust destructor was not properly recognised in this country. In a combined electricity, gas and heat station there should be an engineer-in-chief, with departmental engineers for each particular service, and the chief engineer would be in a position to decide which department could most economically supply the needs of the customers and whether those needs should be met by gas, electricity or steam. The rivalry between electricity and gas might stimulate both of the parties concerned to carry out developments, but that rivalry was not always conducive to the economical interests of the community. Another advantage which would be derived from a combined electricity, gas and heat station would be that the mains of the various services would radiate from the same point. As a rule, the more undertakings were linked up the better would be the diversity factor, as the peak loads of the various undertakings did not as a rule synchronise. In a certain scheme for a garden city in which heating, hot water and electricity were to be supplied from a central station, the peak loads showed that it would be to the advantage of the city electricity supply station to be coupled up with the station supplying the garden city, as the current peak load at the garden city came at a time when there was less load on the other station. The question had been raised as to whether there will in the future be a demand for the supply of heat. It seems that that demand would develop more rapidly than some might expect. If a supply were offered there would be many who would be glad to accept it, because it would enable boilers to be disposed of, and the cost of stoking, ash removal, &c., would be eliminated. There was also the question of public health. During the coal strike there was a decline in the death-rate in Glasgow owing to the clearer atmosphere. Anyone comparing the atmosphere hanging over London on a heavy day with that of New York, where the use of soft coal is prohibited, would appreciate the difference. The heating business was, he said, increasing in America. There were some 336 towns which had their district heating systems, and some thirty new plants were laid down last year. Most of the heating plants were working in connection with electric supply stations. If such combined stations were to be developed in this country care had to be taken to see that only those that were suitably situated were used for the purpose. The individual circumstances of each case had to be investigated in respect to load anticipated, and the district over which it would have to be distributed. If those circumstances were not taken into account the result would be unsatisfactory from a financial standpoint, and progress would be retarded.

As the hour was late when the discussion was concluded, the authors were not called upon to reply, and Mr. Ingham Haden merely remarked that there had been no real opposition to his main proposals.

South-East Lancashire Electricity Scheme.

AN inquiry into the South-East Lancashire electricity scheme, which lasted three days, was held at the Town Hall, Manchester, last week by the Electricity Commissioners, comprising Sir John Snell, chairman, Sir Harry Haward, Mr. H. Booth and Mr. W. Leckie. As many of our readers are aware, this scheme has for its object the co-ordination of all the leading sources of electrical power in the area lying between Wigan, Rochdale, Glossop and Knutsford, by the formation of an advisory board. This board will direct expansion, investigate the conditions under which the plants already in existence are operating, and the supply and transmission resources. Acting upon the advice of a technical committee, the board will suggest to the various undertakings which come under its charge under what conditions they shall continue to operate. The alternative to this voluntary board is the official joint electrical authority which would have certain definite powers. The joint advisory board would not possess borrowing powers, whereas a joint electrical authority would be able to borrow money to carry out new work.

The scheme, as presented, involves a capital expenditure of £13,000,000 during the next ten years, a sum which is said to be £1,800,000 less than would be expended by individual enterprise during the same period. The scheme also provides for the closing down of several stations within the area, the building of others, and new intercommunication cables. Already, it was stated, about 80 per cent. of the stations involved are linked one with another, and the local authorities which have approved of the scheme of an advising board represent 93 per cent. of the rateable value of the area. Mr. Tyldesley Jones, K.C., who appeared for the promoters of the scheme, said that the board would be composed of forty-eight representatives of constituent authorities to be appointed by the twenty-eight authorised undertakings. To form a committee of engineers, it was proposed that any undertaking which generated more than 5 per cent. of the total in the area should have power to elect one member. This ratio, it was explained, would produce a committee of ten men, who would be admitted to board meetings but have no power to vote. Voting on the board itself would be by one vote for each member. If the proposal were adopted the members of the board would be bound by common understanding not to extend without consulting the board, so that the board, with full data available, might have the opportunity of suggesting any other plan it thought desirable. There were further obligations on the board—that it should consider any recommendations for the better supply of electricity, and that it should itself initiate plans to that end, for the guidance of the constituent authorities and for the information of the Commissioners. The board will have no coercive power under the law as it stands.

Stalybridge is the only authority which desired to be excluded from the scheme. In its case the periodicity of the current supplied is 40, whereas the standard of the rest is 50. It was pointed out that to change over would involve an expenditure of £400,000. Ultimately, however, this authority decided to come in on special terms. The Yorkshire Electric Power Company also raised an objection to the inclusion of Saddleworth and Springhead, but Sir John Snell said that as far as he could see the powers of the company would not be affected by the scheme. In concluding the inquiry, Sir John remarked that the scheme was a novel one, which would require careful consideration by the Commissioners, but promised to give the Commissioners' decision as early as possible.

PERSONAL AND BUSINESS ANNOUNCEMENTS

WE are informed that Mr. R. B. Hodgson, who for some years has been general manager of Ashmore, Benson, Pease and Co., Limited, Stockton-on-Tees, has been elected a director of that company.

WE are informed that the civil engineering contracting business of EXOR. of L. P. Nott, lately carried on at Bristol, Birkenhead, Beaufort, Cromarty, Minehead, Newport, and Sea Mills, has now been acquired by Nott, Brodie and Co., Limited, of 19, Clare-street, Bristol, to which it is requested that all future communications should be addressed.

WE are asked to state that Messrs. W. C. and K. A. Mountain, of Sun Buildings, Newcastle-on-Tyne, and Mr. William Walker, of Ashtead, Surrey, have made mutual arrangements by which, in cases entrusted to either party, in which an independent expert opinion is required, the clients of either party can, if they wish, have the benefit of the other party's advice.

MR. LIONEL ROBINSON, B.A., has taken into partnership Mr. W. E. Warrilow, A.M.I.E.E., as and from January 1st, 1922, and under the name of Lionel Robinson and Co. they will continue the sole agency for resistance materials and wires made by Henry Wiggin and Co., Limited, Birmingham, which Mr. Lionel Robinson has held for the past fifteen years. The company's offices are at 3, Staple-inn, London, W.C. 1.

LOGARITHM CABINET.—We have received from Messrs. Bowman and Murdoch a small device designed to facilitate the use of logs. It consists of a small oblong box with a narrow celluloid window running its full length. On the upper edge of the window is attached a scale of numerals. Within the box are two rollers rotated by external knobs, and on the rollers is mounted a table of logarithms. By operating one or other of the rollers any line of figures can be brought immediately below the fixed column of numerals. Whilst the device may ensure accuracy in reading, we are not prepared to say it could be used as rapidly as the usual tables.

ANGLE-COMPOUND AIR COMPRESSORS AT BOWDEN CLOSE COLLIERY

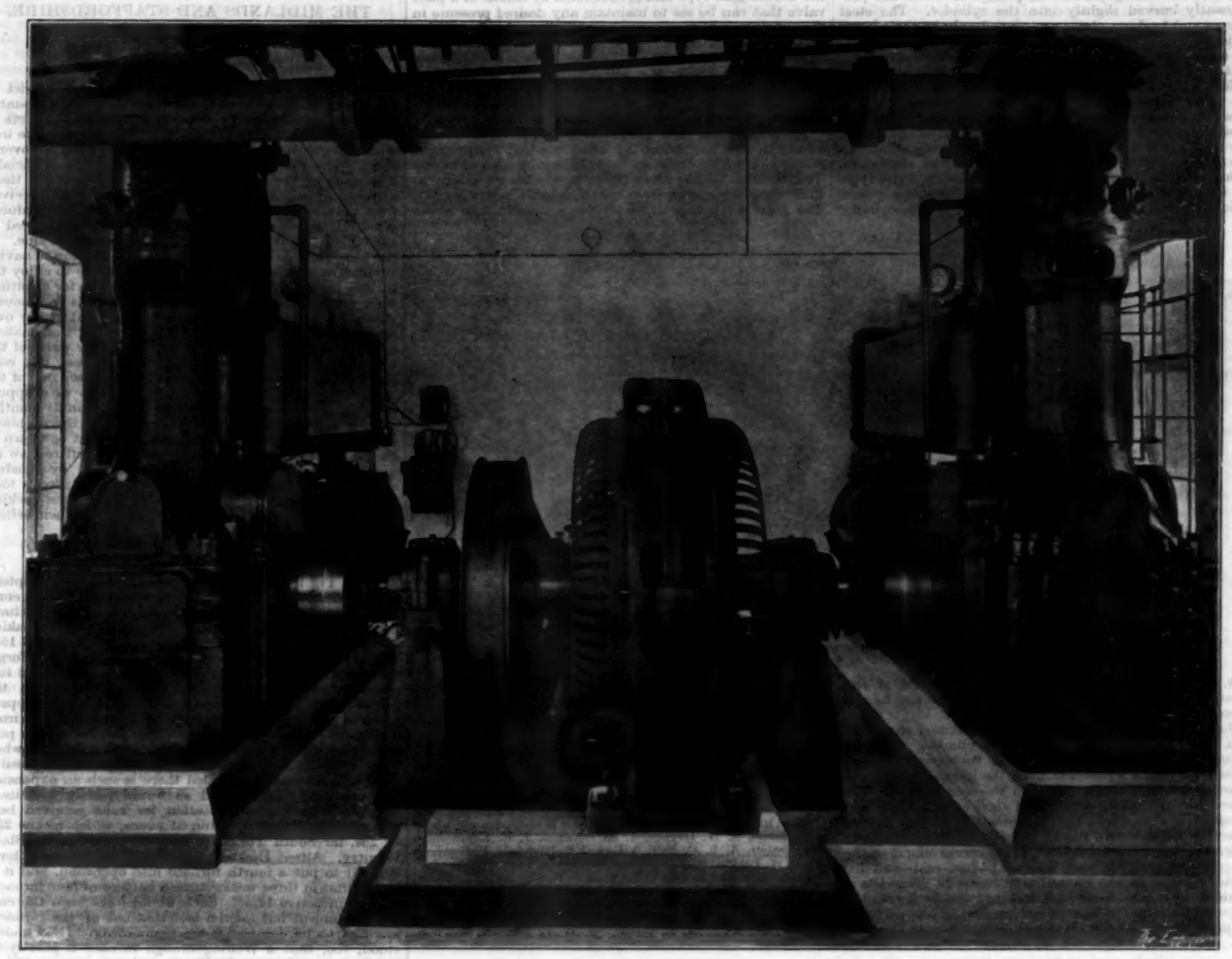


FIG. 1—VIEW OF PLANT RUNNING AT 200 REVOLUTIONS PER MINUTE

Angle-Compound Air Compressors at a Colliery.

WHAT is said to be a novel type of air compressor so far as this country is concerned has recently been installed at the Bowden Close Colliery near Newcastle-on-Tyne, of Messrs. Pease and Partners. The plant in question consists of two angle-compound compressors made by the Sullivan Machinery Company, of Chicago, arranged on each side of, and driven in common by, a 350 horse-power Allis-Chalmers self-starting synchronous motor. The makers understand that the compressors are the first in the United Kingdom to be driven by a self-starting synchronous motor, all others electrically operated being, so far as they are aware, driven by induction motors. In Fig. 1 we reproduce a photograph of the plant taken while it was running at its rated speed of 200 revolutions per minute.

The Sullivan angle-compound air compressor is distinguished in its general arrangement by the fact that, while the low-pressure cylinder, with its frame, connecting-rod and crosshead, is arranged horizontally, the high-pressure cylinder and its accompaniments are disposed vertically, the two pistons being actuated by a single crank. Air compressors arranged in this manner have been previously produced by other makers, but it is claimed by the Sullivan Company that its design is the only one of the type now being built commercially. Among the advantages urged in favour of the arrangement are the balancing of the reciprocating masses which it permits, the reduction of the floor area required, and the accessibility which it gives to the working parts. It is also claimed that the installation, maintenance, and attendance charges are reduced, that the choice of drive is unrestricted, and that the power required per unit of air compressed is low. On the first-named advantage, the improved degree of balance that can be realised, the others depend in large measure. The balancing effect of the angular arrangement of the cylinders springs from the fact that the disturbing forces arising from the vertically reciprocating parts reach their maximum value—namely, when the piston is at either end of its stroke—at the same time as that at which those produced by the horizontal parts have the minimum value—namely, when the horizontal piston is at the middle of its stroke and *vice versa*. The net disturbing forces are thus substantially constant in amount, and can therefore be almost completely neutralised by the constant centrifugal force derived from rotating masses fixed to the crank shaft. Incidentally, the angular arrangement permits the adoption of a common crank pin of short length for the two connecting-rods and the spacing of the cylinder planes a few inches apart instead of at several feet as in the case of a twin-crank engine with the two cylinders arranged side by side. A single-crank engine with the two cylinders placed at 180 deg. to each other would secure the same economy of overall width and absence of cross twist on the crank shaft, but such an arrangement would greatly increase the overall length of the plant and would result in the inertia forces of the two reciprocating systems reaching their maximum and minimum values simultaneously and not at 90 deg. out of phase.

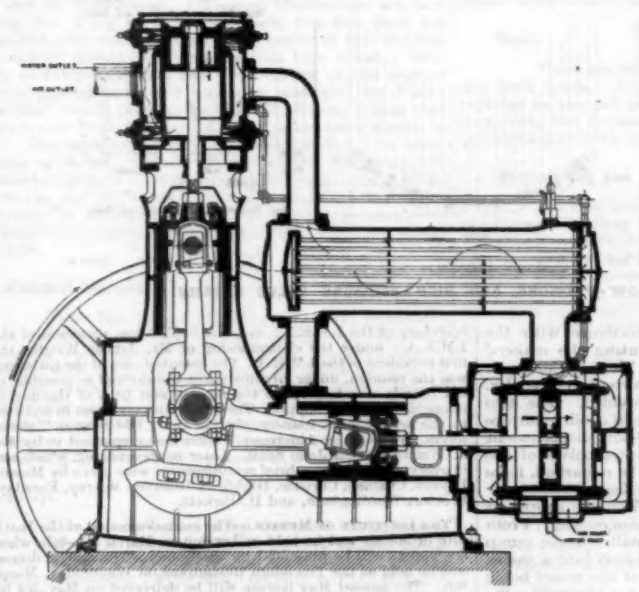


FIG. 2—SECTIONAL ELEVATION OF COMPRESSOR

Apart from the general arrangement, considerable interest attaches to the design of the details of the compressor. At one end of the main frame the horizontal, overhung, low-pressure cylinder is attached. Towards the other the frame carries a vertical pedestal, to the top of which the high-pressure cylinder is bolted. The frame and pedestal are bored internally to form guides for the turned faces of the crosshead shoes. The bottom portion of the main frame is made solid to serve as a reservoir for oil. The crankshaft is supported in cast iron babbited bearings, each of which is made in four parts so as to permit the bearings to be removed by jacking up the shaft, but without disturbing it otherwise. To balance the resultant inertia forces cast iron counterweights are bolted to the crank webs. The fly-wheel, when supplied, is made in halves and is crowned to receive a driving belt. In the Bowden Close installation the fly-wheel is omitted, the shafts of the two compressors, as shown in the accompanying engraving, being directly coupled to the self-starting synchronous motor.

In both cylinders the pistons work within liners forced into the main castings by means of hydraulic pressure. The spaces left between the liners and cylinder castings are used for the circulation of cooling water. The inlet for the air is situated on the underside of the low-pressure cylinder. The air flowing through the inlet passage—shown in the sectional drawing, Fig. 2, as bisected by the water inlet—divides into two streams, which, passing right and left, enter the end chambers of the cylinder. The end chambers are divided into two portions by a horizontal partition, below which are situated the inlet valves and above which are the outlet valves. The air discharged through the latter valves unites into one stream and flows through the intercooler to the high-pressure cylinder. In this cylinder the annular space outside the water jacket is divided into an inlet and outlet portion by a vertical partition—not shown in the engraving.

The valves, inlet and outlet, of both cylinders are of particularly interesting design. In the case of the low-pressure cylinder the ends of the working barrel are closed by valve plates, of which we give front, rear, and sectional views in Fig. 3. In its lower half each plate is pierced with two irregular shaped openings for the inlet of the air, and in

the upper half with a series of slots for the outlet. The inlet openings are covered by a pair of plates in which slots are cut. Between these plates and the valve plates proper are fixed four sets of spring steel fingers—see Fig. 4—and two backing plates, the prongs of which are permanently curved slightly into the cylinder. The steel fingers and backing plates are nipped only at their lower ends, and when suction takes place the orifices are opened by a rolling-like action of the fingers against the backing plates. In the discharge valves the arrangement is different. The valves, as shown in Fig. 4, are of the direct lift type. Each consists of a slotted steel plate, which is pressed against the face of the cylinder valve plate by a similarly slotted cambered spring. The valve and spring are held in position by a stout slotted backing plate. In the high-pressure cylinder the inlet and outlet valves are, as indicated in Fig. 5, both of the rolling spring finger type. In this case the fingers and backing plates are placed inside or outside cages arranged radially round the cylinder

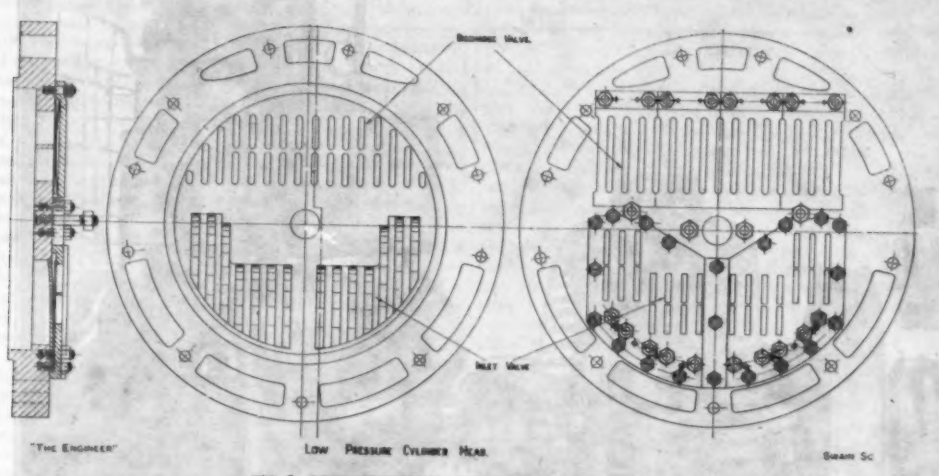
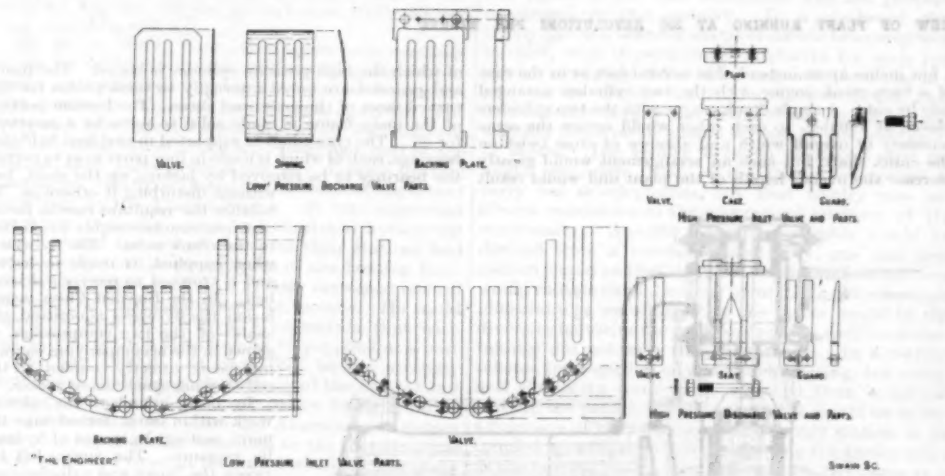


FIG. 3—LOW-PRESSURE CYLINDER VALVE PLATE

ends. There are four such cages at each end of the cylinder, each cage containing two valves with two fingers apiece.

The cooling water, it will be noticed, enters the plant at a point below the low-pressure cylinder. Flowing through the jacket of this cylinder it traverses the intercooler from which it passes through the jacket of the high-pressure cylinder to the outlet on the side thereof. The intercooler consists of a cast iron shell containing a nest of copper or aluminium tubes, through which the cooling water circulates in two passes. The support of the intercooler is derived from the flanged pipe connecting it to the low-pressure cylinder and from a hollow cast iron leg resting on top of the main frame casting. This leg is provided with a blow-off cock and incidentally serves the purpose of a trap for oil or water present in the partially compressed air. In the plant as illustrated in the general



FIGS. 4 AND 5—LOW-PRESSURE AND HIGH-PRESSURE VALVE DETAILS

arrangement the intercooler is in accordance with the above description, this design representing the makers' standard practice. The Bowden Close plant is, however, equipped with a three-pass counter-current intercooler, in which three nests of tubes are provided. The two intercoolers of this plant have a combined cooling surface of 424 square feet for a combined piston displacement of 2020 cubic feet per minute. Two intercoolers of the makers' standard design would, it may be remarked, have a combined cooling surface of 224 square feet.

The lubrication of the plant is based on the supply of oil carried in the bottom of the main frame casting. From this reservoir the oil is drawn by a small plunger pump driven off the crank shaft, and is delivered into a vessel at the end of a stand pipe, the height of the vessel being sufficient to ensure the flow of the oil by gravity to the crank shaft bearings, the crank and crosshead pins, and the crosshead guides of both cylinders. The pump is designed to meet more than the maximum requirement of oil, the surplus from the overhead vessel being returned by an overflow pipe to the main reservoir. The air cylinders are separately oiled by means of a two-feed oil pump.

When the receiver pressure reaches the desired limit an unloading valve attached to the main inlet on the low-pressure cylinder comes automatically into action and completely closes down the supply of air to the plant. The machine then runs under no load until the demand for air once more reduces the receiver pressure below the set limit, at which instant the unloading valve automatically opens again to its full extent. The unloading valve is of the double-beat type and is controlled by means of a pilot valve that can be set to maintain any desired pressure in the receiver. In conjunction with the unloading valve an automatic relief valve is provided on the high-pressure cylinder, which, when the unloading valve is closed, opens communication with the atmosphere and provides an outlet for any air that may leak into the cylinders. The cylinders are thus preserved under a nearly perfect vacuum when the plant is running under no load.

At the Bowden Close plant the compressors, as we said at the outset, are driven by a self-starting synchronous motor and not by the more usual induction type of motor. The motor is of 350 horse-power and takes its energy at 2750 volts, 40 cycles, from the Newcastle power supply. The great advantage of employing a synchronous motor for this purpose consists of the assistance which it gives to the power factor and the consequent reduced rates for power which may be granted by the supply company.

MUNICIPAL ELECTRICAL OLD STAGERS' REUNION.—When is a municipal electrical engineer an old stager? When, having been in municipal service before midnight on December 31st, 1900, he has ever been a chief. Fifty-one of them, among whom were Messrs. S. W. Baynes, J. K. Brydges, J. E. Edgecombe, R. Ferguson, A. L. C. Fell, A. Gay, J. S. Highfield, F. Harman-Lewis, W. Lackie, E. T. Ruthven Murray, A. Page, H. Faraday-Proctor, G. Scott Ram, Sir John Snell, J. E. Stewart, C. D. Taite, H. Talbot, T. P. Wilmshurst, and C. H. Wordingham, sat down to dinner at the Hotel Cecil on Friday, 20th inst., with four guests, Alderman W. Walker, chairman of the *N.J.I.C., Electricity Supply Industry*; Mr. H. Booth, Mr. W. L. Magden, first hon. secretary of the I.M.E.A.; and Mr. S. T. Allen, president of the I.M.E.A.; under the chairmanship of Mr. Arthur Wright, the first president of the I.M.E.A. The essential idea of the gathering was the reunion, under circumstances as informal as possible, of old friends who had borne the burden and heat of the day in municipal electrical supply. There was only one toast in addition to the loyal toasts, namely, that of the "Old Stagers" themselves, proposed by Alderman Walker and responded to by Mr. A. Wright and Sir John Snell. Later in the evening, which was in every way a success, brief reminiscences were given by Messrs. Baynes, Chamen, Christie, Highfield, Ruthven Murray, Farsday-Proctor, Wordingham, and H. Birkett.

THE INSTITUTE OF METALS.—The annual meeting of the Institute of Metals will be held in London on March 8th–9th, when ten papers will be presented for discussion. The annual dinner will be held at the Trocadero Restaurant on Wednesday, March 8th. The annual May lecture will be delivered on May 3rd by Sir Ernest Rutherford, F.R.S., the subject being "The Relation of the Elements." The autumn meeting of the Institute will be held—for the first time—at Swansea on September 20th–22nd. From October to December, as well as during the current quarter, meetings of the various local sections of the Institute will be held in London, Birmingham, Sheffield, Glasgow, Newcastle-on-Tyne, and elsewhere. The Institute of Metals has just issued a practical pamphlet of thirty-two pages, giving in summary form the results of over ten years' research into the causes and prevention of corrosion in condenser tubes. The pamphlet can be obtained, price 2s. 8d. post free, from the Institute of Metals, 14, Members' Mansions, London, S.W. 1.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Continental Pig Iron Competition.

MUCH interest is manifested in this district in the report of the iron and steel masters from this country who have recently visited the iron and steel districts of Lorraine, upon the question of the subsidising of the iron and steel industries of that district by the French Government. The French Government is said to be artificially bolstering up the blast-furnaces and steel works in those districts by supplying them with German coke, received from Germany by way of reparations, at a greatly reduced price. It is believed that this coke is being supplied at something like 50 per cent. below its market value. If the blast-furnace owners of Lorraine, in addition to having supplies of iron ore ready to their hands, are to enjoy the further great advantage of very cheap coke for smelting, their position as competitors with England is enormously strengthened, and the prospects of a revival of our own trade are seriously impaired. Happily, pig iron makers in the Midlands, equally with those in other parts of the kingdom, are determined at all costs to beat this continental competition. This, of course, has been one of the main objects of the Cleveland ironmasters in dropping their price 30s. per ton in a period of less than 2½ months. Only if continental pig iron is kept out can British blast-furnaces be got to work again, and they must be blown in once more or the British raw iron trade will receive its quietus. Even at present prices, Midland ironmasters state that they are producing pig iron at a serious loss. The Belgians during the past week have been seeking keenly for business, but without indicating their selling price.

Pig Iron Down Another 5s.

Pig iron, whether Derbyshire or Northamptonshire and whether forge or foundry material, is not commanding the price it was a fortnight ago, and values have dropped during that period fully 5s. per ton, making current quotations:—Northamptonshire: Forge, £3 15s.; foundry, £4 5s. to £4 7s. 6d. Derbyshire: Forge, £3 17s. 6d.; No. 3 foundry, £4 7s. 6d. to £4 10s. at furnaces. Derbyshire material is being pushed on the market very much just now, but there does not appear to be so great a rush to get rid of Northamptonshire iron. The more favourable terms upon which coke can be purchased brings within a measurable distance the time when local blast-furnace owners in bulk may find it possible to re-light furnaces, provided there is such an expansion and continuity of demand as would justify additional output. The lowest quotation for coke received here this week is 17s. 6d. per ton at ovens, which means 25s. to 26s. for South Yorkshire coke delivered in the Black Country. Alfred Hickman, Limited, of Springvale, have decided to put a fourth furnace into operation, and it is hoped that in three weeks' time a battery of four furnaces will be in active blast. Such would have been the case at the moment but for the fact that one of the furnaces has had to be damped down temporarily. It is understood, too, that a Wellingborough furnace is shortly to be re-commissioned. Midland smelters were surprised and more than a little pleased this week to receive fairly large orders. Tonnages have for some time past been of such a paltry size that orders for 1000-ton lots and one for 1500 tons have given them cause for thought and congratulation. They have not, in an endeavour to revive trade, hesitated to cut prices, and it would appear that prices are now becoming attractive. Buyers have held off so long, and the orders placed have only been for immediate requirements, that it is a pleasure to see a revival of forward buying, if only of a patchy character. It is taken as a sign of better things to come. Another encouraging feature is the reappearance in the market of some continental buyers who formerly took a good deal of iron from this district. Nearly all makers of pig iron report improved business. The blast-furnaces are sorely missing the Staffordshire bar trade, which continues in a depressed condition. A number of the consumers of pig iron have still quantities of the material left on hand, bought when prices were very much higher than those now prevailing. Foreign competition has ceased to be effective, and now that the inflow of continental iron has practically ceased, British makers are keen to re-establish their old connections.

Staffordshire Crown Bars at £11 10s.

Staffordshire makers of Crown bars have taken up the gauntlet thrown down by the Lancashire makers of nut and bolt bars, as reported in this column last week. The Lancashire makers' offer of bars at £11 15s. has been countered by offers from Staffordshire makers to supply at £11 10s. There is, however, little demand, and buyers, even at these prices, are few and far between. The manufacturers of finished iron declare they have never known business so bad, and many of the works in the district are completely idle. The restrictive influence of the Bar Makers' Association is no longer recognised so far as unmarked bars are concerned, and the basis price of £13 has become a special one. The makers of best bars are working about half time, and in their case the Association price standard of £16 is held. The competition of steel in a very narrow market is being severely felt. The small quantity of gas tube strip being made is being sold at prices well below the standard of £13 10s., but as steel strip can be bought at something like £3 less, tube makers are generally preferring this material. Belgian No. 3 bars have again stiffened in price, the latest quotation from this source showing an increase of from 5s. to 7s. 6d. a ton on last week's figures, making the price £10. There is no alteration of note in the galvanised sheet trade.

Steel.

There is little being done in the steel department, though there is a more hopeful tone with regard to steel

sections. Scotch material continues cheaper than that produced locally. A large Birmingham merchant has this week quoted a Belgian buyer for a substantial tonnage of English billets, to execute a foreign contract for steel, no longer obtainable from the Belgian mills. The South Staffordshire district is now suffering from the lack of steel re-rolling business, which for many months was a useful standby. It has become unprofitable to produce bars from billets at the present selling price of finished material, now that the great steel works producing from raw materials are cutting prices to the lowest figure.

Bright Prospects for Foundry Industry.

There were some very optimistic speakers at the annual dinner of the Birmingham branch of the Institution of British Foundrymen on Saturday last, and the progress of science in its application to the work of foundrymen was referred to. Mr. C. Retallack, chairman of the Willenhall and District Ironfounders' Association, remarked that the moulders' strike had drawn attention to the importance of the foundry industry in a way never experienced before. Never in its history had there been such a hungering after right methods as at the present time. He had no fear for the future of the industry. There was a keen spirit of research, endeavour and determination, and he considered the industry was on the way to recover anything that had been lost. All who were engaged in foundries now realised that the forces of foreign competition must be overcome. For many years little headway had been made, but now the industry was making its impression upon the nations of the world, and the activity of the young men with regard to research was very encouraging. Mr. Oliver Stubbs was of opinion that trade was on the turn, and Mr. E. C. R. Marks, president of the Midland branch of the Institution of Mechanical Engineers, pointed out that by the application of abstract science, foundrymen were now able to meet all the requirements of the engineer.

Wages in the Engineering Trade.

The conference between the employers' and workmen's representatives in the engineering trade of the Birmingham and Wolverhampton area, to which I referred under the above heading in my letter last week, and which had as its object the consideration of whether the time had not arrived when the wages paid to boys and youths should be revised, ended in a deadlock. The conference was held in private, and the only statement the employers permitted to go out was that they had made certain proposals for a reduction of wages, and that the parties failed to reach an agreement. The position now, I learn, is that the agreement fixing the wages of boys and youths in the industry came to an end on the employers' application for a revision of the rates, and as the unions have declined to come to any new agreement, there is now no agreed rate of wages for this class of worker employed by firms who are members of the Birmingham and Wolverhampton District Association of the Federation.

The Nuneaton Colliery Trouble.

Further developments have ensued at Messrs. Stanley's Nuneaton Colliery, as a result of which it is estimated 400 or 500 men will be thrown out of employment. It will be remembered that I reported in this column a few weeks ago that the directors had announced that the colliery was not paying, and would be closed down unless the men accepted a 10 per cent. reduction in wages. Eventually, an agreement was entered into under which the colliers agreed to accept a 10 per cent. reduction for a period of three months, providing that the equivalent of such reduction was set aside, and that if the efforts to make the pit pay were successful, such money should be paid to them at the end of the period. If the working still resulted in a loss, they were prepared to forego it. The agreement was subject to a week's notice on either side, and last week the owners, on the ground that the loss had continued, and even increased, enforced this clause serving notices on all the men, numbering about 1100, to cease work. It is understood that only certain seams of the colliery are to be closed down, and men have been signed on to work the portions remaining open. Those signed on will not be subject to the 10 per cent. reduction, but will receive the ordinary rate.

Railway Electrification in the Midlands.

Diverse opinions on the practicability of the electrification of our main-line railways were expressed at a recent joint meeting of the Birmingham Associations of the Institutions of Civil, Electrical and Mechanical Engineers. The chairman, Sir Henry Fowler, chief locomotive engineer of the Midland Railway, remarked that all over the country inquiries were being held as to the future arrangements for the supply of electric current. If a clear lead could be given as to the demands which were likely to be made for transport, it would be of the greatest advantage. They could not neglect the financial side of the question, and a good deal depended on the density of traffic. On main lines with a low density of traffic, the first cost was a very great consideration. With a maximum density of traffic they might agree that electrification was most desirable. In the discussion which took place opinion generally seemed to be against electrification on account of the initial cost.

Coventry Matters.

It is satisfactory to learn that the slight improvement noticable in some quarters of Coventry's industries has been maintained during the past week, and still more so to be assured that the optimistic feeling manifested by certain of the important motor car firms for some little time past is at length being justified. In this connection, one of the largest establishments in the city in the small car business certainly has no cause for complaint, orders having recently come in so satisfactorily that the works are going day and night. The unmistakable signs of some movement in the home demand for the smaller types of care are indeed welcome after the spell of depression which has been experienced. This week a new foundry drew its first oven of malleable castings, and the firm is booking orders for motor work.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE markets for ferrous and non-ferrous metals in this district remain in a comatose condition, and very little business is going on. There seems, however, to be rather a better feeling, probably as the result of a belief that for the present the slump in prices has been arrested. It does not of course follow that the range of prices will not be lower, and the chances are that before the end of the year further falls in iron and steel prices may take place; but for a month or two the markets look like being steadier. Whether this steadiness will bring about a better consumption remains to be seen. It is true that there are a good many impossible prices still maintained in sections of the manufacturing iron and metal trades. Raw material, however, is on a safer level of prices, and it remains to get fuel and labour into a corresponding condition, when there will be a chance for a revival of the manufacturing industries.

Metals.

The market for copper remains in a depressed condition, and there is no sign of any speculative spirit in it. One may therefore conclude that shrewd operators do not yet see any immediate probability of a rise. That they do not see it is presumptive proof that it is not near, and therefore consumers of copper may jog along comfortably with stocks just sufficient to keep them going for a month—or perhaps a week—and this is what they are doing. The fact that speculation is in abeyance, however, means more than the absence of any immediate prospect of a rise; it means also that there is no probability of a fall; for if there were we should see the "bears" becoming rampant. A period of quiescence is before the market, and during that period one may hope that something will be done to bring the manufactured prices into order. It is a little disconcerting to find makers of brazed brass tubes asking just twice as much for their product as makers of yellow-metal rods. The position in tin does not show any special change at present. It is clear that the demand is not now equal to the supply, and there is, besides, the rather unpleasant fact that a large quantity of metal is being held in reserve. As for the stocks held by the Federated Malay States Government, one may perhaps assume that these will not be forced on the market; but there are other Eastern holders who seem rather inclined to realise. The engineering demand for tin remains small, and consumption depends too exclusively on the tin-plate trade. Lately the Welsh makers have been taking less tin, but the American makers have been taking a little more. In the production of tin, as in most other productive work, the costs are slowly falling, and this makes the present prices more reasonable from the seller's point of view than they would have been a year or two ago. The condition of lead is now a little easier, and the manufactured prices have been reduced by £1 per ton. It seems probable that the market has seen its highest prices, and that the supplies to this country will now gradually increase. There is room for a considerable fall this year. Spelter remains fairly steady, but there is no new feature in the market this week.

Pig Iron.

The market in Manchester for pig iron is much as it was, although there are reports from other districts that business is better. This is true of the Cleveland district, because the present price there admits of the resumption of trade both with Scotland and with the Continent, and will justify the blowing in of more furnaces; but it brings no proof that the iron foundry trade of the country is any better, and it is this improvement which is needed to bring about a revival of the demand for pig iron in Manchester. Cleveland ironmasters are now selling No. 3 pig to Germany again, but this does not mean that the trade is going to be better in this district. The actual demand for foundry iron here remains very poor, and indicates that the ironfounders of the district are not getting many new orders for castings; for if they were they would place orders for No. 3 iron, seeing that there is now little prospect of lower prices for a month or two. The expectation of a £4 level for No. 3 in Manchester is fading, and in all probability the price will remain at about £5 delivered during February, and perhaps up to the end of March. Further reductions in furnace coke may be available by that time, but at present most furnaces are up against costs, and some of them are selling at a loss.

Finished Material.

There has been a modification of the "extras" list in bar iron in favour of the buyer, but what is wanted is a much lower level of prices, so as to bring iron on an equality with steel. The demand for sectional steel is poor, but there has been no change in the official prices. South Wales makers are still taking orders at rates which will not be considered by the Midland makers; and, indeed, these latter do not seem anxious to sell at their own prices, maintaining that any sales are made at a loss.

Scrap.

The market for scrap remains very quiet. Foundry scrap is perhaps a little steadier on the belief that the fall in pig iron is at an end for the time; but the prices are unaltered. Steel scrap remains a drug, and it is difficult to sell it at any price. For heavy wrought iron scrap the Lancashire works are paying from £3 to £3 10s. per ton.

A Slight Improvement in the Industrial Situation.

According to the latest return issued by the Ministry of Labour, there has recently been a slight improvement with regard to the number of persons unemployed in Lancashire and Cheshire, the claims to all classes of benefit showing a material decrease, namely, from 446,404 to 427,935. The number of men on short time also showed a decrease of over 5000, while the number of women in this category was 6496 less. The very slight improvement in the industrial situation reflected by the labour statistics is difficult to locate, but it is perhaps equally divisible between the textile and mining industries. The number of persons employed in the engineering trades remains much about the same as it was a month ago. Engineers in nearly every branch of the industry are prepared to take orders at almost any price in order to keep their works open and retain a nucleus of a staff. The textile machinery industry is the only section which can claim to be well off for work, and one well-known firm I am told has orders enough on its books to last three years. Machine tool makers report no sign of improvement, but in certain other branches I have received information of fairly substantial orders having recently been received which will find employment for a few more hands.

The Cotton Manufacturing Industry.

The annual report of the Committee of the Oldham Master Cotton Spinners' Association, which comprises 211 firms owning 19,543,000 spindles, scarcely confirms the optimistic views of Sir Charles Macara, to which I referred last week. The report states that the year 1921 marked the most serious period of depression ever experienced by the cotton trade. During the whole year the trade worked short time, either organised or unorganised. On two or three occasions there was an increased amount of business, which raised hopes that there would be sufficient work to give full time employment to all mills. These hopes were short-lived. At the present time the prospects of trade give no indication of when stabilised improvement may be expected. So long as the loss on trading does not exceed the loss occasioned by closing, every mill struggles to run full time, and many mills continue to run when trading losses are much heavier.

Engineering Works Management.

A course of three lectures on the "Organisation and Management of Engineering Works" will be given at the Manchester University on February 7th, 14th, and March 7th, by Sir Henry Fowler, K.B.E., chief mechanical engineer to the Midland Railway Company. Members of the various engineering societies in the Manchester district are invited to attend.

Manchester Association of Engineers.

I have been requested to announce that the annual dinner of this association, which was fixed for Friday, February 10th next, has been cancelled and that in its place a smoking concert will be held.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is rather more activity to note in the hematite pig iron trade, another furnace having been put into operation by the United Steel Company at Oldside, Workington. This furnace has been idle for twelve months. A further expansion is looked for, but it will be some time before there is general activity at the works. Before the slump set in there were thirty furnaces in active blast. The demand is reported to be a shade fuller on general account. So far as the local consumption is concerned steel makers are taking fair supplies direct from the blast-furnaces at Barrow.

Iron Ore.

There is only a quiet demand for hematite iron ore, business being practically confined to local smelters. The mines of the Hodbarrow Mining Company in South Cumberland remain idle, and nothing is being done in the Barrow Steel Company's pits at Park. At the other mines short time is being worked.

Steel.

There are no new features to report this week in the steel trade. At Barrow there is a fair amount of activity in the rail and hoop mills and also in the steel foundries, but business keeps very quiet, although steel prices were recently cut all round.

Shipbuilding and Engineering.

Vickers Limited are in receipt of a small order, the Furness Railway Company, the owners of the Barrow Docks and harbour, having placed a contract for the building of a self-propelled barge for use in the deepening of the channel and approaches to the port of Barrow. The Furness Railway Company last year received delivery from Paisley of a powerful dredger, and considerable improvements are being carried out in the harbour.

Fuel.

There is a very quiet demand for both steam coal and coke, but an improvement is looked for.

SHEFFIELD.

(From our own Correspondent.)

Welcome Orders.

HAPPILY, a slightly more satisfactory report can be sent this week concerning conditions and prospects in the local engineering and steel trades than was the case last week. The improvement is still far from general, but in one or two departments it is distinct and definite, as attested by the actual placing of orders. The largest of these, it is true, relates to a department that is comparatively new to Sheffield—so far, at any rate, as its present dimensions are concerned—but it is none the less welcome on that account, and it will incidentally bring a good deal of work to other shops. I am now referring

to the order which Metropolitan-Vickers have received from the Government of South Africa in connection with the electrification of the railways. So far as the firm's Sheffield establishments are concerned the order is for seventy electric locomotives, each of which will be fitted with four motors, the whole of which will, I understand, be made in Sheffield and will occupy the works here for something like two years. This will not be put in hand for another four or five months, but in the meantime the Metropolitan-Vickers two Sheffield shops—at Brightside and Attercliffe—will be fairly busy with orders already in hand. There are at present passing through these shops machines destined for Australia, New Zealand, Nigeria, Italy, Belgium and the Central Provinces of Europe, in addition to some very satisfactory home orders. These latter include one hundred tramway motors for the London County Council, and a similar number for Edinburgh, the firm having just received the order for the first instalment of the electrification of that system. Each of these two tramway contracts roughly represents work to the value of about £20,000, but this is a comparatively small item in relation to the railway orders. As it happens, there is already in hand at the Sheffield shops the motors for an electric locomotive being built to the order of the North-Eastern Railway Company. This is intended for passenger traffic service, and is designed to haul a train of 450 tons at 65 miles per hour, and with a maximum safety speed of 90 miles per hour. (This locomotive was described in THE ENGINEER of December 30th last.) Metropolitan-Vickers has felt the depression probably less than any other works in Sheffield, and with these orders in hand it can face the next two and a-half years with equanimity. It may be recalled that at the annual meeting of shareholders in Vickers Limited, the chairman, Mr. Douglas Vickers, indicated that the future developments of the company would be largely in the electrical department, and already this forecast is being fulfilled, for I believe the value of orders booked in the first three weeks of the present year approximates to something like one million pounds.

Work for Steel Makers.

Although the orders referred to in the preceding paragraph relate only to electrical departments, the steel makers will benefit because the frames and casings for the motors will be made in Sheffield, and in the aggregate will represent quite a helpful contribution towards the lessening of unemployment. But apart from these indirect aids, there are promises of orders in other departments. Railway rail making is regarded as one of the minor lines, but the promise of orders for a considerable weight of rails is announced by a couple of firms who do a certain amount of work of this class—Cammell Laird and Co., Limited, and Steel, Peech and Tozer, Limited. Much more than these orders is, of course, needed materially to reduce the volume of unemployment in the city—the registers still totalling over 45,000—but as signs of a disposition to place overdue orders in connection with railway renewals, and the still more welcome beginning of electrification schemes, these tentative efforts should do much to renew confidence. These are, however, the only evidences so far observable of the still distant boom. No more blast-furnaces have been re-started, and, of course, armament departments are doing practically nothing. In fact, the Sheffield Branch of the Inspector of Naval Ordnance's Department has received intimation that the staff must be further reduced, although for some time past it has been at little more than pre-war strength.

An Order from America.

An order has come to Sheffield from the Ford Motor Company of Detroit for a Greaves-Etchell electric furnace of 60 tons capacity—the largest of its kind in the world. The order includes two smaller furnaces of the same type. It is said that the Americans are making larger use of the electric process for making manganese steel castings, and are also extending the production of iron castings from electrically melted iron. The lighter trades of Sheffield are "patchy"—some firms are quite busy and have orders sufficient to keep them going for several months, while their neighbours, equally well known in the trade, are having to discharge many of their employees. Two local firms are sharing a fairly big order for cutlery and other table services just let by the Cunard Company; but seeing that this is an order merely transferred from another Sheffield firm, it does not affect the total volume of trade in the city. The seasonal orders for farm and garden tools are not up to the normal average, while the serious state of the scissor, pocket knife and razor trade cannot be exaggerated. The Sheffield Trades Technical Society, which is organised under the auspices of the Applied Science Department of the University, has lately been devoting special attention to the comparative merits of the American and the English-made file, not entirely to the advantage of the latter. An exhibition was arranged and the criticisms and observations of both employers and workmen invited. The superior finish of the American article was generally admitted, and it was disconcerting to learn that the Americans exported just about twice the total of British exports of these articles in 1920. It was urged that the American makers paid more attention to their customers' requirements and provided more durable and serviceable packing boxes.

Subsidy for French Steel.

Some concern has been occasioned in Sheffield steel manufacturing circles during the week by the report brought home by a prominent official in the trade, who, with other leaders in the industry, has been visiting the iron and steel districts of Lorraine, that there is strong reason to believe that the French Government is subsidising the blast-furnaces and steel works in that district, a course which is acting to the serious detriment of competing countries like Great Britain. It is said that the French Government is selling the coke which it is receiving by way of reparations from Germany to the blast-furnace owners in Lorraine at about 50 per cent. under its market price. The reason for this action on the part of the French Government is purely political. Across the border, at Saarbruck, in Germany, the industry is booming, and the working classes there are not only able to get the necessaries of life, but a British steel manufacturer noticed particularly that on the Saturday evening they were purchasing in the shops of that German town luxuries which are beyond the compass of the purse of our English working classes at the present time. Owing to the dissatisfaction which this contrast causes to the inhabitants of Lorraine, who have, by the Treaty of Versailles, come under the *régime* of the French Government, something has evidently had to be done by the latter in order to stimulate artificially the iron and steel industry in Lorraine.

Converting Canal to Road.

Considerable interest is being taken in the proposal to convert a disused canal running from Chesterfield in the direction of Rotherham into a road, which would link up with existing roads to form an arterial road between these important industrial centres south and north of Sheffield. Eleven miles of the canal would be utilised for this scheme, which is engaging the serious attention of the various local authorities concerned. The idea originated with Mr. C. P. Markham, head of the well-known engineering firm bearing his name, and having very large interests in the Derbyshire, Notts and South Yorkshire coalfields. The Great Central Railway Company, owns the canal, and views the project with favour. From end to end the proposed new highway would have a fall of only 38ft., and would thus facilitate easy and cheap road transport in the districts affected. Adjoining it there are about 850 acres of land available for works sites, &c. The making of the new road would also abolish thirty-five bridges, many of which are unsafe for heavy traffic. It is hoped that the Road Board will provide the money. Extensive road construction schemes are also contemplated in the neighbouring county of Lincoln. It is recognised that the present method of construction is inadequate to the heavy traffic now passing over these roads, and an expenditure of £50,000 has been sanctioned for tar-macadamising some of the first-class main roads in most serious need of attention, and an ultimate expenditure of £400,000 is contemplated.

The Coal Position.

So far as the position of industrial fuels is concerned there is practically no change in the conditions as compared with a week ago. Certainly in some few directions there are signs that current consumption is on an increasing scale. Such circumstances, however, are very isolated, and, on the other hand, consumption in other directions is not so much as a short time ago. Altogether the inland demand is on a disappointing scale, and there is not likely to be any appreciable improvement for some time. Expansion will, necessarily, be on a very restricted scale. The position in regard to export business is much the same. Current business continues to be on the small side, and there is a great amount of competition for any orders that are passing. There are plenty of inquiries in the market for forward business for export, but orders are being placed very very slowly. In many cases there is still a considerable difference in pit-head prices for similar quality coals, and there is also a difference in pit-head prices for inland and export business. Under the present market conditions this is not to be wondered at, but at the lower level of values—in comparison with those that were operating, say, in October last—prices are steadier. Up to the end of December a considerable tonnage had been sold on contract at what, during the last few months of the year, were prices far higher than current rates. Naturally, this had a certain effect on the monthly "ascertainments," and the average selling price at collieries will be substantially lower as from the beginning of this year owing to the falling out of these high-price contracts. It is expected that the results for the district as a whole for January will bring about a considerable reduction in wages for the month of March. The demand for gas fuels is not so active as a short time ago. This is chiefly due to the fact that works are picking up the heavy stocks that they put down in view of price reductions operating in the near future. Blast-furnace coke is not moving nearly so well as a week or two ago. The fact that no increased number of furnaces has been put into operation, and that the demand for export is on a comparatively small scale, is telling against this market showing any recovery. Prices are on the weak side, and there is a considerable amount of selling pressure—in some cases at exceptionally low rates

NORTH OF ENGLAND.

(From our own Correspondent.)

Industrial Position Improving.

THERE are not wanting signs that the general industrial position in the North of England is gradually improving, but enormous leeway has to be made up before there is anything like a return to normal activity. The situation in the coal trade is more encouraging than for many months past, and an improvement can be recorded in the iron trade, several more furnaces having been put into operation. All these are hopeful signs, but they do not warrant an easy optimism, for even yet the total volume of business is very restricted. Still, there appears to be hope of progressive improvement, and though traders are sceptical about the downward trend of prices having been arrested, possibly some stabilisation has now been reached which will encourage them to come forward. The shipbuilding and engineering trades are still suffering from a serious lack of work.

Cleveland Iron Trade.

The position of the Cleveland iron trade has not undergone much alteration on the week. There has been an improvement in the volume of trade, but it is only relative. Buying is still restricted, and will have to be on a much bigger scale before one can say that a real revival has set in. Steel makers are getting rid of their accumulated stocks of iron, and as local iron is now getting cheaper than imported iron, foreign competition in pig iron has largely ceased. Thus the ironmaster has at least the command of the home market, but the trouble is that the home market is so very limited. Many of the foundries are not working, and the general slackness reacts upon the demand for iron. A fair quantity of Cleveland foundry iron has been sold to Scotland, and as it can be landed at Grangemouth for less than 100s., it can successfully compete with Scotch No. 3 at 105s. per ton. A few small foreign orders have been booked, but these are almost negligible, and it seems that the price must fall still lower before this trade can be resumed on normal lines. Still more urgent is it that confidence should be restored, the exchanges stabilised, and the world peace established. All these are factors which need attention before any real trade revival can take place. There is no change in pig iron prices, No. 1 and siliceous iron being 95s., No. 3 Cleveland 90s., No. 4 foundry 87s. 6d., No. 4 forge 82s. 6d. and mottled and white iron 80s. The export premium on Cleveland pig iron has been abandoned.

Hematite Pig Iron.

There is a much better demand for East Coast hematite than for foundry iron, and the output is going steadily into consumption. Still, competition for orders is very keen, and although 95s. per ton is the general quotation for mixed numbers, and 97s. 6d. for No. 1, these figures, it is stated, might be shaded on a firm offer of business. However, even at 95s., East Coast hematite is the cheapest in the country, and this district is consequently getting the bulk of the orders.

Iron-making Materials.

The foreign ore market has weakened, and business has been recorded in best Rubio ore at 25s. per ton c.i.f. This is certainly a low price, and it may not be possible to repeat it. There is, however, extremely little business, and trade is chiefly directed to Mediterranean ores, which are relatively cheaper. Coke prices are steady. Makers assert that they are already selling at a loss, and that no further price reductions can be looked for at present. On the other hand, ironmasters regard coke at 27s., or even 26s. 6d. per ton delivered, as far too dear, and there the matter rests, buyers only purchasing for immediate needs.

Manufactured Iron and Steel.

The demand for manufactured iron and steel is very disappointing. Makers refuse to cut prices any further, as they are already selling at a loss. On the other hand, buyers are inclined to play a waiting game, and as a result the position of the industry is going from bad to worse. Only a very small proportion of the plant in the district is working, and production is approaching its lowest ebb. Prices, however, are firmly held for home trade, though concessions are being made in the export trade.

The Coal Trade.

A very firm tone characterises the Northern coal trade. At present there is a good market for any class of coal, with delivery over the next two or three weeks, but after that the position is not quite so satisfactory, and values, though seemingly strong at the moment, may alter when the present congestion is alleviated. The recent stormy weather has played havoc with the shipping movements, and large numbers of steamers are suffering serious detention in the docks. Another important factor in sustaining the market for prompt is the tremendous number of miners off work through the influenza epidemic, which is responsible for a rather large reduction in output in both counties. The forward market is not opening out to any great extent, and though occasional contracts are heard of, some of which are placed at very low figures, there is not anything like the volume of contracting going on that should take place at this time of the year. The uncertain factor regarding the future is as to the reflected influence on the market of the easement in coals on both the Scottish and Welsh markets, and there are many large exporters and others firmly convinced that in a short time the same disintegrating influences will operate in Northumberland and Durham to bring prices down. Whether this result is likely to be realised here or not is speculative, but in the meantime forward transactions are to some extent held in abeyance in order to watch developments, and at the same time to be able to take advantage of any favourable movement in prices. There are said to be a number of fresh inquiries in circulation, but it is doubtful if any of them are pressing or urgent, though business could be booked if quotations became suitable. Best and second screened steams of every brand are firm, and well stemmed for a fortnight or more ahead. Small steams are also very much better placed for early shipment. Gas fuels are in brisk call for the next week or two. Prime kinds are in special favour, while the poorer grades are also well held for prompt. Coking coals are steady, with values fairly well held. Bunkers are brisk for the home bunkering trades, but shipments are not large. The coke market is very quiet for all kinds of furnace and foundries, but gas coke is in better demand.

SCOTLAND.

(From our own Correspondent.)

Another Quiet Week.

INDUSTRIAL wheels are moving very slowly. Very little progress towards a general resumption of work has been made since the beginning of the year, and, consequently, markets are dull and of little interest. In some directions considerable progress towards cheaper production has already been made, but in others the movement has been slow. However, it would now appear that the time for which buyers have been waiting is nigh. Wages in almost all industries have been lowered, and costs of raw materials are much more favourable. The absolute rock bottom may not yet have been reached, but general conditions are undoubtedly more conducive to a revival in trade. Stocks everywhere must have practically disappeared, and manufacturers must soon come

into their own. Money is scarce and taxation high, but there are rents in the cloud of depression, and signs are apparent that the efforts to improve trade in general will meet with some reward in the near future.

Wages Questions.

The question of wages continues to excite interest. In some trades the scale has fallen rapidly until now it would almost appear as though the workers would require to increase the length of the day in order to earn a requisite return in accordance with the cost of living. In other directions, however, a fairly high standard is yet maintained, and further adjustments are now under consideration. The decision in the case of the railwaymen in Scotland will be known before these lines are in print, and the result will have a far-reaching effect on industry. Railway charges in Scotland are a severe drawback to progress, and the high cost of wages is partly blamed for keeping up rates. The dockers' wages may also come in for further moderation. The question of low-paid surface workers in the mining industry has been under consideration this week, and one of the principal points, that of the subsistence allowance payable under Clause 5 of the terms of settlement, was disposed of. Generally speaking, the agreement is as follows:—A maximum allowance of 1s. per shift will be paid to male workers eighteen years of age and over, earning under 7s. per day, and 6d. per shift to male workers under eighteen years, earning under 3s. 6d. per day. Female workers, eighteen years and over, earning under 5s. per day, will be paid up to 8d. per shift, and female workers under eighteen years, earning under 2s. 6d. per day, up to a maximum of 4d. per shift. This agreement will apply as from January 1st, and remain in force for three months from that date, and thereafter will be subject to review on the application of either side of the Board.

Pig Iron.

The pig iron trade moves very slowly. Prices are now much easier, and makers are willing to do all in their power to meet buyers, so that now that the steel and iron works are showing some signs of life, better things may be looked for.

Steel and Iron.

Prospects in the Scotch steel industry seem a little brighter. Some works are getting under weigh again, and others are expected to follow suit. Orders have been very scarce for a long time now, but there is evidence that more interest is being taken. Prices are much cheaper, and may become more so, and buyers are more eager to take advantage of any cheap material coming on to the market. Foreign competition is much less prominent, and local makers are gradually becoming more able to compete in the general market at home and abroad. Steel plates and sectional material are on the slow side so far, but in sheets some business has been done. Malleable bar iron does not show much progress yet, but a change for the better is expected in the near future. The engineering and shipbuilding trades are very quiet.

Coal.

The Scotch coal trade has not been very brisk during the past week; in fact, the trade has not yet recovered the activity apparent at the end of last year. Round coal is not in heavy demand, but a fairly steady request for smalls is reported. The industrial demand is poor, but as the steel and iron works get into their swing, this is likely to improve. Household fuel has been busier, though not to the extent usual at this time of the year. The export inquiry has been comparatively fair, but shipping has been interfered with by the severe weather, which has also disorganised work at the pitheads. The collieries in the Lothians and Fifeshire are well booked up and employment is comparatively good. Aggregate shipments for the week amounted to 195,885 tons, against 200,139 tons in the preceding week and 309,286 tons in the same week in 1913.

Slump in Employment at Rosyth.

Great indignation has been expressed in Rosyth over the intimation reducing the staff of Rosyth Dockyard from 6500 to 2600. The men say that they were brought from dockyards in the south and promised steady employment. Further, the Admiralty is stated to have promised that whatever the future naval policy of the Government should be, Rosyth would be maintained at full strength at all costs. Now Rosyth, the most modern of the dockyards, has evidently been dropped, while others are to be continued in commission.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Maesteg Miners and Notices.

It is not long since the Maesteg area was the scene of a certain amount of labour trouble, and it looks as if the district will again figure prominently in this respect. It is worth noting that this is the district in the charge of the President of the South Wales Miners' Federation, Mr. Vernon Hartshorn. The miners at a mass meeting on Saturday last decided to give fourteen days' notices on the non-unionist question, but the men's leader is doing his best to bring the coalowners into the trouble, and what is really only a dispute between two unions is made to appear a matter of responsibility for the owners. According to Mr. Hartshorn, there are 278 non-unionists in the district, and the miners' organisation will not be satisfied until it has within the organisation 100 per cent. of the men employed in the area. There are also outside effects which have come into operation, and which he describes as "the blighting influences and disturbing forces of those parasitical organisations which battened on the vitality of the main labour organisations." By this is meant that another labour organisation is in the field, this being the National Enginemen, Boilermen, and Surface Craftsmen's Association. Mr. Hartshorn is very angry that anyone should dare to trespass within his sphere of influence. He therefore causes the workmen to tender notices and informs the coalowners that they will have to decide whether they will have their collieries worked by Federation men alone or by the above-mentioned Association, in the interests of which Mr. Robert Shirkey, of Glasgow, is very busy in South Wales. Mr. Hartshorn says that it will be scandalous if further loss is brought upon the district through the interference of outside organisations. He entirely ignores the right of the workmen to decide to which trade union they shall belong, and he does not mind apparently what trouble comes to the whole of the community in the Maesteg area so long as there shall be only one trade union in his district, and that the Miners' Federation. However, it appears that the Enginemen, Boilermakers and Surface Craftsmen's Association is proceeding with the organisation of the craftsmen in the Maesteg area, so that it is not unlikely that a certain amount of trouble will develop.

Dock Charges.

Reference was made last week to certain concessions in non-statutory charges which the Bristol Channel Dockowners' Association had agreed to, provided the Committee, representative of the trading interests, accepted them as a final settlement of its claims. These concessions were to come into operation on the 16th inst. The General Committee informed the trade that the concessions in charges would be in force as from that date, but at the same time it decided to write to the Dockowners' Association to the effect that such reductions in charges could not be regarded as a complete solution of the question. An interesting development is that the Dockowners' Association has notified the General Committee that as the concessions were not accepted on the conditions set forth, the modifications in the charges would not operate, and the whole matter would again have to come before the Dockowners' Association. To this the General Committee has replied that when the trade agreed, at the request of Mr. Felix Pole and the dock companies, to suspend proceedings to test the legality of the increases in, and now, non-statutory charges since 1914, it was assumed that every effort would be made to arrive at a friendly settlement and that the trade would not be subsequently faced with an ultimatum from the dock companies. It would be an impossible position for the trade to accept the slight concessions offered by the Dockowners' Association as a settlement of the vexed question of non-statutory charges. The Committee adds that it is now inclined to the opinion that the dock companies do not recognise the present serious state of the coal and shipping trades and are not rendering that assistance which might fairly be expected from them. The effect of high railway rates and dock charges upon the South Wales coal trade has been discussed by the secretary of the Coalowners' Association, who, dealing with the figures of trade for the month of December, states that of the increase of two million tons in coal exports as compared with the same month of 1921, South Wales shared to the extent of only 471,000 tons, while other districts shared to the extent of no less than over 1½ million tons. These facts are recommended to the attention of the railway and dock companies, and particularly so in view of the fact that the shipping charges at the Tyne ports are more favourable to foreign coal shipments than those in South Wales, and that dispatch is better at those ports than it is at the port of Cardiff.

Work in the Coalfield.

A partial resumption of work has been made at the No. 1 pit of the Fernhill collieries at Treherbert, and nearly 500 men have signed on. These collieries have been closed for some months, but about a month ago the No. 2 pit was re-started. Guest, Keen and Nettlefold's, Limited, are developing the Fochriw and Penydarren coal area. In the case of the former, two drifts are being driven into four seams of excellent house coal. A seam of nearly 3ft. in thickness has already been reached. It is expected that the full development of the property will take about two years, by which time there will be employment for about three to four thousand men.

Current Business.

There scarcely seems to be quite so much business about, and yet the coal market does not display any material change. The inquiry from abroad is certainly quieter, adverse financial conditions being partly accountable for this state of things. Exporters with commitments, who have calculated on coal prices giving way, must be faring badly, as rates of freight for most Mediterranean destinations have recently stiffened sufficiently to have turned what might have yielded a few pence profit into a pretty certain loss. Tonnage must be getting more distributed, and, further, its movement has been upset by bad weather, with the result that anyone in need of a spot boat has to pay heavily. Best Admiralty coals are obtainable at 24s. 6d., and ordinary Admiralty large at 24s. Monmouthshire qualities are without notable alteration, but sized coals are not so firm. Best smalls are fairly steady at 18s. to 18s. 6d., patent fuel being quoted at 24s. to 27s., and foundry coke at 30s. to 35s. Anthracite coals are on the easy side, with the exception of nut coals, which are scarce and keep in good demand.

Latest News from the Provinces.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

BUSINESS has become very quiet in steel and tin-plates, and it is certain that unless orders come along better, some mills will have to close down. Furthermore, to accept lower prices than those now ruling would mean heavy losses to manufacturers.

Regulating Coal Prices.

The Commercial Committee of the South Wales Coalowners' Association has had a meeting to consider the financial position of the industry, and more especially the current market prices of coal. It was realised that there were serious difficulties in the way of the adoption of artificial expedients for the regulation of prices, but the opinion nevertheless prevailed that the present conditions were operating adversely to the interests both of the workmen and employers, and whatever was practicable should be done to improve the position. No definite decision was arrived at, but the question is to receive further consideration.

SURVEY OF THE NATIONAL COAL RESOURCES

THE Fuel Research Board has made arrangements for the recognition of the Lancashire and Cheshire Coal Research Association as the local Committee working under the Board for the purpose of dealing with the physical and chemical survey of the coal seams in the Lancashire and Cheshire areas. The chairman of the Committee is Mr. Robert Burrows and the Director of Research Mr. F. S. Sinnatt.

It has long been felt that an important aspect of the great problem of the conservation of the national coal resources involves the study and classification of the coal seams which are at present being worked or developed, and also of seams or portions of seams which are being left unworked or are thrown aside above or below ground. This study and classification on its directly practical side must deal primarily with the suitability of each particular coal for those purposes for which its individual qualities render it most adequate, *e.g.*, for gas making, coke making, steam raising, or for domestic use.

This question of survey has for some years been receiving the anxious consideration of the Fuel Research Board, but the unstable conditions which prevailed in the coal industry during and since the war have necessarily led to the postponement of the work of organisation. It is now, however, considered that the time has arrived when a beginning can wisely be made.

The Fuel Research Board believes that this work can be most effectively carried out with the help of local committees in which colliery owners, managers and consumers are associated with the representatives of the Fuel Research Board and the Geological Survey. By this combination, not only will local knowledge and experience be made available, but the initiative of those most deeply interested in the practical aspects of this Survey will be secured.

The survey work will thus from the outset assume a practical character, for the selection of seams for examination will be in the hands of those who are in the best position to estimate the relative importance of the problems awaiting solution. The selected seams will be submitted to physical and chemical examination by the local experts; and, as a result of this examination, a further selection will be made of those which appear to justify experiments on a practical scale to test their suitability for particular uses or methods of treatment. This experimental work will be carried out either at H.M. Fuel Research Station or at other works, as may be found most convenient.

The first Committee, that referred to in the opening paragraph, is already actively at work in the Lancashire and Cheshire district. It is felt by the Fuel Research Board that the experience gained in the work and organisation of this Committee will be of great value in the establishment of Committees in other districts when the time is ripe for further developments.

CALENDARS, DIARIES, &c.

H. J. SKELTON AND CO., Limited, London.—Wall calendar with daily tear-off sheets.

IGRANIC ELECTRIC COMPANY, Limited, 147, Queen Victoria-street, E.C. 4.—A greeting card for 1922.

W. STRAKER, Limited, 49–63, Ludgate-hill, E.C. 4.—Monthly tear-off sheet calendar printed in blue and red.

HENRY SIMON, Limited, 20, Mount-street, Manchester.—Very neat calendar with daily tear-off sheets.

FLOWERDEW AND CO., Temple Bar Chambers, 227–228, Strand, W.C. 2.—Monthly tear-off sheet calendar.

GEORGE REVEIRS, Limited, 4 and 5, Greystoke-place, Fetter-lane, E.C. 4.—Card printed with the year's calendar in blue.

MILLWALL ENGINEERING COMPANY, Limited, 21, Panton-street, S.W. 1.—A serviceable blotter suitable for the desk.

PECKETT AND SONS, Limited, Bristol.—A wall calendar, with monthly tear-off sheets. A view of one of the firm's locomotives is reproduced in colour.

BROWN BAYLEY'S STEEL WORKS, Limited, Sheffield.—Monthly tear-off calendar, with an article on "Why Iron and Steel Rust," with some interesting diagrams.

MAWDSLEY'S, Limited, Dursley.—Wall calendar with monthly tear-off sheets. A picture in colours, entitled "A Refreshing Interval," by Val Davis, is reproduced.

W. OTTWAY AND CO., Limited, Orion Works, Ealing, W.—Wall calendar with pictures of the firm's manufactures reproduced on the monthly tear-off sheets.

HULSE AND CO., Limited, Ordsal Works, Manchester.—Wall calendar with monthly tear-off sheets. On each sheet a picture of one of the firm's productions is reproduced.

AITON AND CO., Limited, Derby.—Calendar for 1922. A picture in colours of the river Yealm, Devonshire, is reproduced and the whole makes an exceedingly attractive calendar.

HART ACCUMULATOR COMPANY, Limited, Marshgate-lane, Stratford, E. 15.—A blotting pad, suitable for the desk. On either side of the blotting pad a calendar has been printed.

BROWN BROTHERS, Limited, Great Eastern-street, E.C. 2.—Tear-off sheet calendar, two months to a page. Six humorous illustrations in colour are reproduced from drawings by Lawson Wood.

HARRISON AINSWORTH, 197, The Grove, Hammersmith.—Monthly tear-off sheet calendar. Also a calendar which has been reproduced as a blue print drawing, and which is very effective.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., Limited, 8, Great George-street, S.W. 1.—Two calendars with monthly tear-off sheets. On each sheet is a reproduction of one of the firm's manufactures.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	37/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	26/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 12 6	—
No. 1 Foundry	5 10 0	—
No. 3 ,,	5 5 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 15 0	4 15 0
No. 1	4 17 6	4 17 6
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 2 6	4 2 6
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
MIDLANDS.		
Staffs.—		
All-mine (Cold Blast)	11 10 0	—
Part Mine Forge	*None offering.*	
North Staffs. Foundry (*Nom.*)	5 0 0	—
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 5 0 to 4 7 6	
,, Forge	3 15 0	—
(3) Derbyshire—		
No. 3 Foundry	4 7 6 to 4 10 0	
Forge	3 17 6	
(3) Lincolnshire—		
Basic	4 5 0 to 4 7 6	
Foundry	4 12 6 to 4 15 0	
Forge	4 5 0 to 4 10 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	6 5 0	—

MANUFACTURED IRON

	Home. £ s. d.	Export £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best ,, ,,	17 0 0	—
N.E. COAST—		
Common Bars	12 10 0	—
Marked ,,	13 0 0	—
Tees	14 10 0	—
LANCS.—		
Crown Bars	13 0 0	—
Hoops	16 5 0	16 0 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	14 0 0	—
Hoops	16 0 0	—
MIDLANDS—		
Marked Bars (Staffs.)	16 0 0	—
Crown Bars	12 0 0 to 13 0 0	
Nut and Bolt Bars	11 10 0 to 12 0 0	
Gas Tube Strip	13 0 0 to 13 10 0	
Hoops (*Nom.*)	16 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	14 0 0	—
Ship Plates ⅜in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ⅜in.	12 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 10 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 10 0	—
Soft Billets	7 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
MANCHESTER (*Prices irregular and uncertain, unchanged*)—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0 to 13 0 0	
Bessemer Billets	12 0 0	—
Hard Basic	10 0 0	—
Soft ,,	8 0 0 to 9 0 0	
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
MIDLANDS—		
Small Rolled Bars	10 0 0	—
Bessemer Billets	7 15 0 to 8 0 0	
Hoops	12 0 0 to 12 10 0	
Gas Tube Strip	10 10 0	—
Sheets (24 W.G.)	13 10 0 to 14 0 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 10 0	
Angles	9 10 0 to 10 0 0	
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	9 10 0 to 10 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/- to 19/9
Block Tin (cash)	158 10 0
,, (three months)	160 0 0
Copper (cash)	64 17 6
,, (three months)	65 12 6
Spanish Lead (cash)	23 2 6
,, (three months)	23 0 0
Spelter (cash)	25 17 6
,, (three months)	26 5 0
MANCHESTER—	
Copper, Best Selected Ingots	68 0 0
,, Electrolytic	73 0 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 3½
Lead, English	24 10 0
,, Foreign	23 10 0

(*Metal prices practically unchanged*).

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£26	10/-
,, 6 p.c. to 8 p.c. ,,	£25 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£24 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£75	26 6
,, 1 p.c. ,,	£91	31/-
,, 0·75 p.c. carbon	£110	37/6
,, carbon free	2/1 per lb.	
Metallic Chromium	5/1 per lb.	
Ferro Manganese	(per ton) £15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£21 10 0 scale 6/- per unit	
,, Vanadium	21/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

	SCOTLAND.	Export.
LANARKSHIRE—		
(f.o.b. Glasgow)—Steam		23/-
,, ,, Ell		22/6
,, ,, Splint		24/- to 27/6
,, ,, Trebles		25/-
,, ,, Doubles		23/-
,, ,, Singles		18/-
AYRSHIRE—		
(f.o.b. Ports)—Steam		23/-
,, ,, Splint		24/-
,, ,, Trebles		25/-
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		20/- to 23/-
Screened Navigation		28/-
Trebles		26/-
Doubles		23/-
Singles		18/6
LOTHIANS—		
(f.o.b. Leith)—Best Steam		22/6
Secondary Steam		22/-
Trebles		26/-
Doubles		23/6
Singles		18/6
	ENGLAND.	
(8) N.W. COAST—		
Steams		34/-
Household		40/- to 55/-
Coke		31/-
NORTHUMBERLAND—		
Best Steams		23/6 to 24/6
Second Steams		21/6 to 22/-
Steam Smalls		13/6 to 14/-
Unscreened		21/6
Household		25/- to 30/-
DURHAM—		
Best Gas		21/6 to 22/-
Second		20/- to 21/-
Household		25/- to 30/-
Foundry Coke		32/- to 33/-
SHEFFIELD—	INLAND.	
S. Yorks. Best Steam Hards	26/- to 27/-	—
Derbyshire Hards	25/- to 26/-	—
Seconds	24/- to 25/-	—
Cobbles	24/- to 25/-	—
Nuts	20/- to 21/-	—
Washed Smalls	17/- to 18/-	—
Best Hard Slacks	17/6 to 18/-	—
Seconds ,,	14/- to 15/-	—
Soft Nutty ,,	14/- to 14/6	—
Pea ,,	10/- to 12/-	—
Small ,,	8/- to 9/-	—
House, Branch	39/- to 40/-	—
,, Best Silkstone	37/6 to 39/-	—
Blast Furnace Coke (Inland and Export)	17/6 to 22/6	
	(9) SOUTH WALES.	
CARDIFF—		
Steam Coals:		
Best Smokeless Large		24/6 to 25/-
Second ,, ,,		24/- to 24/6
Best Dry Large		24/- to 24/6
Ordinary Dry Large		23/6 to 24/-
Best Black Vein Large		23/- to 23/6
Western Valley ,,		22/6 to 23/-
Best Eastern Valley Large		22/6 to 23/-
Ordinary ,, ,,		21/6 to 22/6
Best Steam Smalls		17/6 to 18/6
Ordinary ,,		12/6 to 17/6
Washed Nuts		27/6 to 32/6
No. 3 Rhondda Large		27/6 to 30/-
,, ,, Smalls		19/- to 20/-
No. 2 ,, Large		22/- to 23/-
,, ,, Through		19/- to 21/-
,, ,, Smalls		15/- to 16/-
Coke (export)		32/6 to 35/-
Patent Fuel		24/- to 27/-
Pitwood (ex ship)		32/- to 33/-
SWANSEA—		
Anthracite Coals:		
Best Large		55/- to 57/6
Seconds		45/- to 50/-
Red Vein		40/- to 45/-
Big Vein		50/- to 52/6
Machine-made Cobbles		72/6 to 75/-
Nuts		72/6 to 75/-
Beans		55/- to 57/6
Peas		20/- to 21/-
Breaker Duff		7/6 to 7/9
Rubbly Culm		10/- to 11/-
Steam Coals:		
Large		24/- to 25/-
Seconds		23/- to 24/-
Smalls		12/6 to 16/-
Cargo Through		20/- to 22/-

(1) Delivered. (2) Not Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for exports. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Capital and Industry.

FOLLOWING upon the example of the sugar manufacturers who issued debentures to the public some months ago in order to raise funds for the reconstruction of factories, three of the leading engineering concerns in the Nord are adopting the same method of obtaining capital. Several towns and communes in the devastated regions have also issued public loans, thereby testifying to a general belief that there must exist considerable reserves of money throughout the country. It does not appear, however, as if the applications for loans, except those offering the best security, have met with any particular success, and it is certain that the public is loth to put money in industrial ventures until the situation becomes much more satisfactory than it is at present. Not only is capital needed for the reconstruction of works and factories, but money must be available before orders of any importance can be distributed, and it follows that there can be no sustained industrial revival until, by means of payments on account of reparation or by foreign loans, it will be possible to proceed with the execution of the vast amount of work to be carried out in the devastated regions and elsewhere. The reluctance of capital to participate in industrial ventures is due very largely to the unstable character of business. So far, orders have been withheld in the belief that prices must come down with the steady fall in raw material. There is still a good deal of fluctuation in raw material prices, but taken all round, they are, as compared with a few months ago, so much lower that a considerable reduction might be expected in the prices of manufactured goods. Raw material prices are, however, a much smaller factor in prime costs than wages and overhead charges, which have been considerably increased by the shorter hours of labour and heavy taxation, and wages can hardly be reduced to any great extent so long as the cost of living remains at its present level. All sorts of laws, decrees and regulations have been enforced with a view of bringing down living costs, but while the producer has been able to cheapen commodities the consumer has not so far derived any benefit. The only hope for industry, therefore, lies in increasing the output for the wages paid, and it is believed that something will be done to achieve this result by a modification or the suppression of the eight hours' day. It is only when the output per man reaches something like the pre-war standard, and wages are reduced proportionately to a diminution in the cost of living, that there can be any real hope of industrial stability.

The State Railways.

One of the proposals for the future working of the State railways is to divide the system up amongst the companies, and it is possible that that may be done so far as concerns the lines that encroach upon the Paris-Orleans system. That company has running rights over a part of the section from Paris to Saumur, Nantes, Quimper and Landernau, and at one time the State tried to induce it to relinquish its rights. Now that the State is to be relieved of the management of the lines, the Paris-Orleans Company has made application for the cession of the railway from Paris to Brest as well as of the State system to the south of that line. Should the application be accepted the Montparnasse Station in Paris will be necessarily included in the concession. Meanwhile the details in connection with the transference of the State railways to a company which is to be formed with capital subscribed by the departments and communes and by the public, are being worked out by the commission, and it is probable that the Bill authorising the formation of the company will be introduced into the Chamber at an early date.

Dirigibles.

The French Government is maintaining a very reserved attitude over the question of airship construction. Before doing anything further it is awaiting developments and acquiring fresh experience which is believed to be necessary in view of the unconvincing results obtained with the dirigibles previously constructed in this country, and especially with the three German airships which were surrendered under the terms of the Versailles Treaty. The Dixmude was taken over by the Marine and was intended to be used for survey work over the Mediterranean and North Africa, but for some time past the German airship has been lying in its shed near Toulon waiting for repairs which the authorities are reluctant to carry out. As the Dixmude is already four years old, which is regarded as the normal life of an airship, it is feared that repairs will be continually absorbing large sums of money. The L-133 has had to be taken down at Maubeuge before it could render any useful service, and the Nordstern, or Méditerranée as it is now called, is still waiting in its shed at St. Cyr until arrangements can be made for handing it over either to the military or naval services. It is feared that the Méditerranée will share the fate of the other airships. Dirigible balloons have not lost favour for military purposes. The authorities are merely of the opinion that it is prudent to await the results of technical investigations in this country, and of the progress being carried out elsewhere, before embarking upon the construction of new airships.

Foreign Trade.

The returns of foreign trade in 1921 show a heavy declension as compared with the preceding year, the total value of imports being estimated at 23,549 million francs, or 26,357 million francs less than in 1920. The value of exports was estimated at 21,553 million francs, a declension of 5341 million francs. These estimates are not reliable, as the returns for the two years were based upon different monetary values, and as offering a better comparison the Customs are now in the habit of publishing the weights, from which it appears that the total for 1921 was 37,973,686 tons, representing a decline on the previous year of 12,558,240 tons. On the other hand, the exports, estimated at 16,001,428 tons, showed an augmentation of 9,146,190 tons, due almost entirely to raw material.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

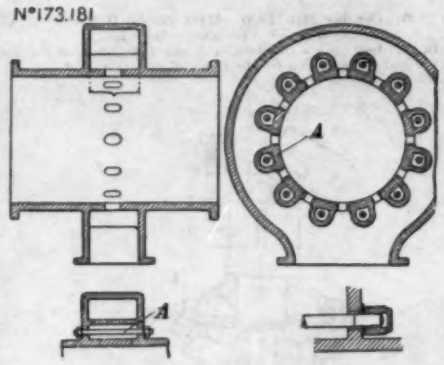
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM ENGINES.

173,181. March 22nd, 1921.—UNIFLOW ENGINES, J. Romeyn, 162, Rue Emile Feron, St. Gilles, Brussels.

IN order to strengthen the walls of uniflow engine cylinders in way of the exhaust ports, the inventor arranges tie bolts A

N°173,181



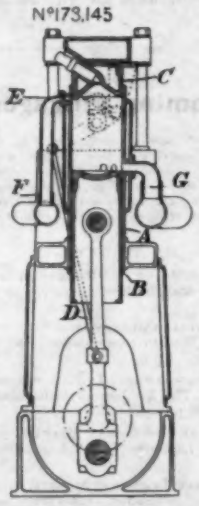
as shown. Leakage from the atmosphere into the exhaust belt is prevented by threading the bolts through pockets cast round the cylinder. Alternatively the bolts may have cap nuts fitted with gaskets.—*December 20th*, 1921.

INTERNAL COMBUSTION ENGINES.

173,145. November 25th, 1920.—TWO-STROKE UNIFLOW ENGINES, The North British Diesel Engine Works, South-street, Whiteinch, Glasgow, and J. C. MacCall Maclagan, 14, Park Corner, Westland Drive, Glasgow.

In this engine both the piston and cylinder have a reciprocating motion, but the cylinder head is fixed. The cylinder A slides between guides on the main frame at B and over the cylinder head C at the top. The cylinder head is fixed to the main frame

N°173,145



by the columns shown. The reciprocation of the cylinder is effected by means of links D attached to the connecting-rod end, by moving the inlet ports E with reference to the cylinder head, controls them as required. Telescopic joints are provided in the inlet pipe at F and in the exhaust at G.—*December 29th*, 1921.

MEASURING AND TESTING INSTRUMENTS.

155,264. December 13th, 1920.—IMPROVED APPARATUS FOR MEASURING THE TEMPERATURE OF WINDINGS IN ELECTRICAL MACHINES AND APPARATUS, Aktiengesellschaft Brown, Boveri and Cie., of Baden, Switzerland.

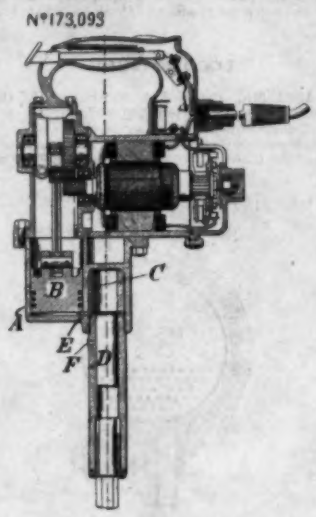
This invention renders it possible to measure constantly the temperature at any desired point of a high voltage coil. This is effected by making the vessel containing the liquid or gaseous expansion fluid of the thermometer at least partly of an electrically conducting material, and by connecting it conductively to the winding. The pipe which connects this vessel in the usual manner to the indicating device of the measuring apparatus is likewise a conductor, and is fixed and insulated in the same manner as a high voltage exit lead. The expansion vessel may be placed upon or between the turns of the winding. A portion of the actual winding may also be made hollow, and the cavity filled with the expansion fluid.—*December 22nd*, 1921.

MACHINE TOOLS AND SHOP APPLIANCES.

173,093. October 7th, 1921.—ELECTRO-PNEUMATIC HAMMERS, *L. W. Goold, 5, Corporation-street, Birmingham.*

In this hammer an effort is made to give a very sharp and decisive blow on the tool. Air is compressed in the cylinder A by means of the electric motor shown. During the downward stroke of the piston B a small amount of air is driven through the passage C to the space above the hammer D and sets the latter in motion downwards. The hammer passes and uncovers the port E at the time when the air in A is compressed to the maximum. The air thus rushes into the hammer cylinder and drives the hammer forward vigorously. Exhaust ports are provided

N°173,093



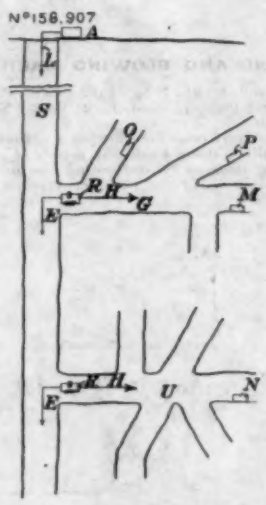
at F. The hammer makes its return stroke under the influence of the partial vacuum caused by the piston B receding.—*December 29th*, 1921.

WIRELESS TELEGRAPHY.

158,907. February 9th, 1920.—WIRELESS SIGNALLING IN MINES, Gesellschaft für Drahtlose Telegraphie M.B.H., 9, Tempelhofer Ufer, Berlin.

A is a transmitting station on the surface. To this station an antenna L is connected and a considerable portion of it hangs vertically down the shaft S as far as possible from the walls. R R are two tuned oscillatory circuits arranged in an

N°158,907



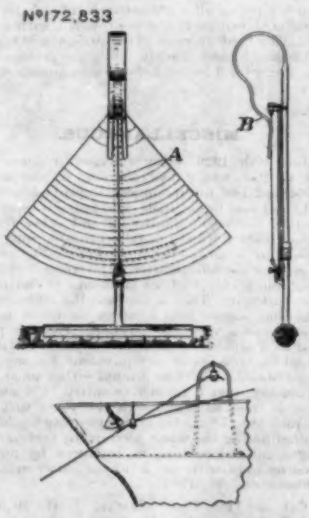
upper level G and a lower level U. To each of these is connected a receiving antenna E substantially of the same length as the antenna L. On the other side of these circuits is connected an antenna H arranged along the gallery. Receivers are shown at O P and at M N.—*December 22nd*, 1921.

SHIPS AND BOATS.

172,833. October 27th, 1920.—A SOUNDING DEVICE, A. J. Marson, 15, Bridge-street South, Grimsby.

This device is intended for use in connection with a warp trailing over the stern of the vessel along the bottom. The

N°172,833



length and angle of the warp naturally give a measure of the depth of water. The instrument takes the form of a quadrantal plate pivoted at its apex in a frame which has a trough-like

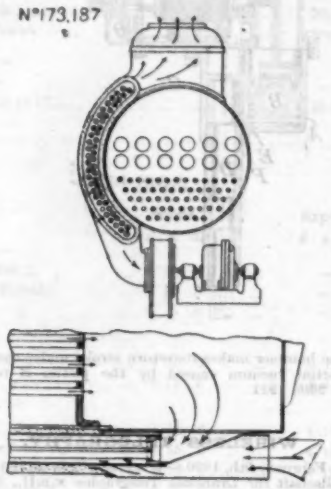
base to engage the warp. The plate is engraved with graduations along arc-shaped lines. The various arcs correspond with the length of warp let out and the graduations, read against the central wire A, give the depth directly. A spring clip B is provided so that the plate may be gripped while the instrument is taken off the warp for reading.—*December 22nd*, 1921.

LOCOMOTIVES.

173,187. April 5th, 1921.—AIR HEATERS, H. Boltshauser, Hardturmstrasse 19, Zurich, Switzerland.

For the purpose of heating the air of combustion for locomotive furnaces the inventor passes it round a nest of tubes arranged on the side of the boiler. The products of combustion are taken

N°173,187



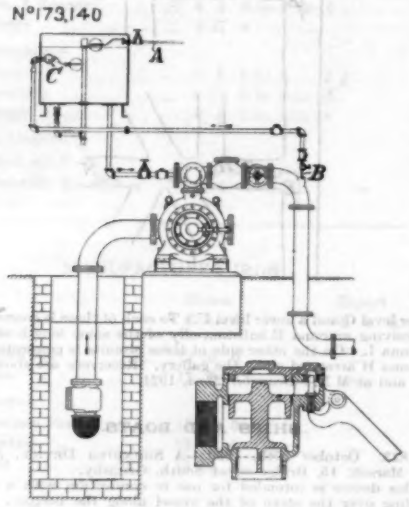
rom the smoke-box, as shown in the lower view, and pass through the tubes to a smokestack at the back. The air, entering at the front of the casing surrounding the tubes, is withdrawn at the rear by a fan and is forced into the fire-box.—*December 29th*, 1921.

PUMPING AND BLOWING MACHINERY.

173,140. November 13th, 1920.—FIRE PUMPS, C. F. Jones and Mather and Platt, Limited, Park Works, Newton Heath, Manchester.

In order to ensure a centrifugal fire pump against being started up automatically without a sufficient supply of priming water, and thus being damaged by overheating, the inventors supplement the usual service of priming water A, taken off the town's

N°173,140



mains, with a tapping off the discharge side of the main pump. This tapping is shown at B and is provided with a special float valve at C. This float valve is of the differential type, as shown in the detail sketch, and quickly refills the priming tank in the event of the water level falling below a safe minimum.—*December 29th*, 1921.

MISCELLANEOUS.

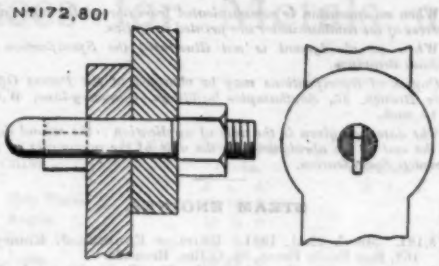
172,065. July 30th, 1920.—COMBINATION OF SOLID AND LIQUID FUELS, G. P. Lewis, 9, Dacre-street, Westminster, London.

This invention has for its object improved means of combination of solid and liquid fuels, and is more especially applicable to certain classes of lignitoidal and other forms of solid carbonaceous matter which usually crumble into small pieces when exposed to atmospheric conditions. The inventor thus soaks or sprinkles the solid matter to be treated with water containing a soluble alkali, such as ammonia or caustic soda, and subsequently dries it. This action has the effect of converting the carbonaceous matter into a rotten condition and facilitates its conversion into a very fine powder. The fine powder is at once soaked in a sufficiency of a partially solvent hydrocarbon, such as a coal tar creosote or its equivalent, for one to two days. The paste so obtained is then ground either once or twice, as may be necessary, and a further quantity of a suitable heavy hydrocarbon is then admixed with the paste to give a liquid sufficiently mobile to be used in an appropriate liquid fuel burner. In lieu of alkalinating the water used in the preliminary soaking a somewhat similar effect can be produced by powdering dry slacked lime or soda with the solid carbonaceous matter after drying.—*November 30th*, 1921.

172,801. October 11th, 1920.—BOLTS, J. R. McKinlay, 104, West 84th-street, Seattle, Washington.

This bolt is intended for use in situations where one side of the work is inaccessible. At the opposite end to that which is threaded the bolt is pierced by a tapered slot. A loose tapered key is fitted in this slot. When the bolt is to be threaded through its hole it is turned so that the key lies horizontally. It is then turned through a right angle, so that the key

N°172,801

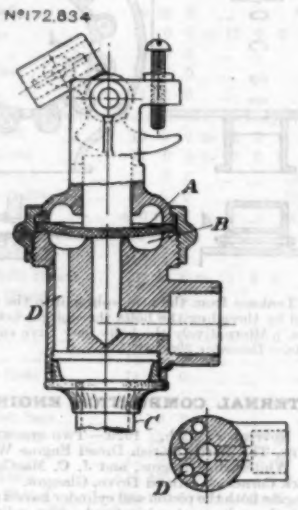


drops partly out of the slot and engages with the work.—*December 22nd*, 1921.

172,834. October 27th, 1920.—BALL COCKS, D. M'Callum, Villa Jeanette, Golf-street, Carnoustie, Scotland.

In this ball cock a diaphragm A takes the place of the usual valve and is controlled by the plunger and cam as shown. The

N°172,834



water, coming in through the central passage, escapes into the annular space B, when the diaphragm is lifted, and passes to the outlet C by the group of holes D. The valve is said to be more silent in action than the usual pattern.—*December 22nd*, 1921.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. Lecturette, "Fuels and the Boiler-house," by Mr. L. M. Jockel. 8 p.m.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—The Engineers' Club, Coventry-street, W. Smoking concert and informal dinner. 7 p.m.

ROYAL SOCIETY OF ARTS: INDIAN SECTION.—John-street, Adelphi, W.C. 2. "The Timbers of India and Burma," by Mr. A. L. Howard. 4.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse on "Journalism," by Viscount Burnham. 9 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Lecture Theatre, Literary and Philosophical Society, Newcastle-on-Tyne. "Marine Diesel and Marine Oil Engines," by Mr. K. O. Keller. 6.30 p.m.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: MERSEYSIDE BRANCH.—University Engineering Building, Liverpool. "Micro-structures of Metal and What They Mean to Engineers," by Mr. E. A. Atkin. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: IRISH CENTRE.—Royal College of Science, Dublin. Lecture, "The Development of Electricity Supply in Switzerland," by Mr. E. M. Johnson. 8 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Memorial Hall, Albert-square, Manchester. Paper, "Organisation of Production," by Mr. J. W. Curtis. 7 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington. The following papers will be read:—"On the Diffusion of Solutions," by Mr. T. H. Litthlewood; "On a Special Apparatus for the Measurement at Various Temperatures of the Thomson Effect in Wires," by Mr. H. R. Nettleton; "A Defect in the Sprengel Pump: Its Causes and a Remedy," by Mr. J. J. Manley. 5 p.m.

JUNIOR GAS ASSOCIATION.—Westminster Technical Institute, Vincent-square, S.W. 1. Lecture: "Electrical Power," by Mr. A. Hugh Seabrook. 7.45 p.m.

SATURDAY, JANUARY 28TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' Visit to the Central Telegraph Office of the General Post Office. 10 a.m.

MONDAY, JANUARY 30TH.

INSTITUTION OF ELECTRICAL ENGINEERS: DUNDEE SUB-CENTRE.—Royal British Hotel, Dundee. Smoking concert. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. Cantor Lecture II.: "Inks," by Mr. C. Ainsworth Mitchell. 8 p.m.

TUESDAY, JANUARY 31ST.

ILLUMINATING ENGINEERING SOCIETY.—Royal Society of Arts, John-street, Adelphi. Discussion, "The Use of Light as an Aid to Aerial Navigation," to be opened by Lieut.-Colonel L. F. Blandy. 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Variable Stars" (Lecture I.), by Dr. H. H. Turner. 3 p.m.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—"The Locomotive Cylinder in Design, Manufacture and Maintenance," by J. G. Mitchell, B.A. 6.30 p.m.

THE ENGINEERS' CLUB, MANCHESTER.—"A Business Trip to Canada and the U.S.A.," by J. Phillips Bedson. 7.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, Tower-hill, E. "Two-cycle Diesel Marine Engines." 6.30 p.m.

WEDNESDAY, FEBRUARY 1ST.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, Clerkenwell, E.C. 1. Paper: "The Design and Testing of Motor Cycle Engines," by Mr. P. G. Kay. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Savoy-place, Victoria Embankment, W.C. "The Determination of the Decrement of a Distant Sending Station," by Major J. Erskine-Murray and Mr. B. Williams; "Some New Methods of Radio-navigation," by Major J. Erskine-Murray and Captain J. Robinson. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—University, Edmund-street, Birmingham. Lecture: "Single and Three-phase Commutator Motors with Shunt and Series Characteristics," by Dr. S. P. Smith. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Surface Printing by Rollers in the Cotton Industries," by Mr. A. Wilcock. 8 p.m.

THURSDAY, FEBRUARY 2ND.

LIVERPOOL ENGINEERING SOCIETY.—Exchange Station Hotel, Liverpool. Annual dinner. 7 p.m. for 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Droughts and Floods" (Lecture I.), by Sir Napier Shaw. 3 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "The Interconnection of Alternating-current Power Stations," by Messrs. L. J. Romero and J. B. Palmer. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: TEES-SIDE SUB-CENTRE.—Cleveland Technical Institute, Middlesbrough. "Electricity Applied to Household Purposes," by Mr. C. T. S. Arnett. 7 p.m.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "Radiological Research and the Examination of Materials," by Dr. V. E. Pullin. 5.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Municipal College of Technology, Manchester. "Coal: Some Unsolved Problems," by Mr. F. S. Sinnatt. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Annual dinner. Midland Hotel, Birmingham. Reception 6.30.

FRIDAY, FEBRUARY 3RD.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. "Utilisation of Waste Heat from Internal Combustion Engines," by Major W. Gregson. (Lantern.) 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse: "The Mount Everest Expedition," by Lieut.-Colonel Sir Francis Younghusband. 9 p.m.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—Gordon Salon, Holborn Restaurant, Holborn, W.C. 1. Costing Conference. "The Necessity for Scientific Costing." 2.30 p.m.

SATURDAY, FEBRUARY 4TH.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Institution meeting arranged at Wakefield for February 4th has been cancelled.

INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. "Foundry Accounts, Costs and Statistics," by Mr. R. Dunkerley. 4 p.m.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: MERSEYSIDE BRANCH.—University Engineering Building, Liverpool. "An Outline of Russian History," by Mr. C. C. Stevenson. 7.30 p.m.

MONDAY, FEBRUARY 6TH.

BRADFORD ENGINEERING SOCIETY.—Bradford Technical College. "Planning and Control of Production," by Mr. R. O Herford. 7.30 p.m.

TUESDAY, FEBRUARY 7TH.

MANCHESTER METALLURGICAL SOCIETY.—College of Technology, Manchester. Paper: "The Attack on Brasses by Solder," by Mr. E. L. Rhead. 7 p.m.

FRIDAY, FEBRUARY 10TH.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. Questions and general discussion. 8 p.m.

FRIDAY, MARCH 3RD.

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION.—Queen's Hotel, Birmingham. Annual meeting. 12.30 p.m.

THURSDAY AND FRIDAY, MAY 4TH AND 5TH.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. Annual dinner, Thursday, May 4th, at Connaught Rooms, Great Queen-street, W.C.

FAREWELL DINNER.—A farewell dinner was held in honour of Mr. Charles Lees, on his retirement from the post of superintendent engineer of Elder Dempster and Co., Limited, at Doan's Reception Room, Oxford-street, London, W., on Wednesday, January 11th. Nearly sixty guests were present, under the chairmanship of Mr. Picton H. Jones, among them being nearly the whole of the London office staff of the firm, with many other friends from South Wales, Liverpool, and elsewhere.

CONTRACTS.—In connection with the order entrusted to Braithwaite and Co., Engineers, Limited, West Bromwich and Newport, Mon., for 114 miles of 6ft. diameter steel piping for supplying water to the city of Bombay, Royce, Limited, Trafford Park, Manchester, have received an order for the full equipment of electrical overhead travelling cranes, eleven in number, for workshops which Messrs. Braithwaite are erecting to carry out the work. Royce, Limited, have also received an order for a two-motor electric telpher with self-dumping grab of 14-cwt capacity from the Worcester Corporation, in connection with a scheme for an extension of the plant of its electricity station.—The Société Metallurgique de Sambre et Moselle has secured an order for 40,000 to 45,000 tons of steel rails and accessories from the Argentine State Railways.